STUK-B 92 / JUNE 2008

B

Regulatory control of nuclear safety in Finland

Annual report 2007

Erja Kainulainen (ed.)

Säteilyturvakeskus
Strålsäkerhetscentralen
Radiation and Nuclear Safety Authority

STUK-B 92 / JUNE 2008

Regulatory control of nuclear safety in Finland

Annual report 2007

Erja Kainulainen (ed.)

STUK • SÄTEILYTURVAKESKUS
STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

Osoite/Address • Laippatie 4, 00880 Helsinki
Postiosoite / Postal address • PL / P.O.Box 14, FIN-00881 Helsinki, FINLAND
Puh./Tel. (09) 759 881, +358 9 759 881 • Fax (09) 759 88 500, +358 9 759 88 500 • www.stuk.fi

ISBN 978-952-478-371-2 (print) Yliopistopaino, Helsinki 2008
ISBN 978-951-478-372-9 (pdf)
ISSN 0781-1713

KAINULAINEN Erja (ed.). Regulatory control of nuclear safety in Finland. Annual report 2007. STUK-B 92. Helsinki 2008. 81 pp. + Appendices 68 s.

Keywords: nuclear energy, nuclear facility, nuclear waste, regulatory control, safety indicators

Abstract

This report covers the regulatory control of nuclear safety in 2007, including the design, construction and operation of nuclear facilities, as well as nuclear waste management and nuclear materials. It constitutes the report on regulatory control in the field of nuclear energy, which the Radiation and Nuclear Safety Authority (STUK) is required to submit to the Ministry of Trade and Industry pursuant to section 121 of the Nuclear Energy Decree.

No events occurred at the Olkiluoto and Loviisa nuclear power plants that would have endangered the safe use of nuclear energy. Three reactor scrams occured due to disturbances at Olkiluoto 2 in 2007. The number is considerably higher than average over the past few years. The safety significance of the events was low.

No individual occupational radiation dose exceeded the limit set for nuclear power plant workers. Radioactive releases were low and the dose calculated on their basis for the most exposed individual in the vicinity of the Loviisa and Olkiluoto nuclear power plants was well below the limit laid down by Government Decision.

In 2007, the safety of the Loviisa plant was assessed more intensively and extensively than usual due to the renewal of the plant's operating licence. According to STUK's assessment, the facility is safe and operated well, based on which it supported the extension of its operating licence until each plant unit will have operated for 50 years. The licence conditions state that two periodical safety reviews must be conducted at the Loviisa nuclear power plant during the next licence term by the end of 2015 and 2023.

The indicators depicting the effectiveness of STUK's action, i.e. the safety performance indicators for nuclear power plants, did not indicate changes that would have called for an immediate reaction from STUK.

In 2007, STUK reviewed the detailed design of Olkiluoto 3, witnessed component manufacturing at manufacturers' premises and oversaw plant construction at Olkiluoto. Based on the results of oversight, STUK can state that, despite the design changes and the deficiencies detected in construction and manufacturing, the original safety and quality objectives for the plant will be achieved.

Posiva Oy is constructing an underground research facility for the final disposal of spent nuclear fuel at Olkiluoto. STUK oversees the design and implementation of structures and systems important to safety, and has not observed any deviations compromising safety.

No events endangering safety occurred at the FiR 1 research reactor. The radiation doses of those working at the research reactor and radioactive releases into the environment were clearly below the set limits.

No events occurred in nuclear waste management that would have endangered safety. In the field of nuclear material safeguards, the use of nuclear materials in accordance with current regulations and the completeness and the correctness of nuclear material accounting were verified.

STUK verified that nuclear liability in the event of nuclear damage has been taken care of according to legislation.

The total costs of nuclear safety regulation in 2007 were €13.2 million. The total costs of operations subject to a charge were €12.0 million, the full amount of which was charged to the licensees and licence-applicants.

Contents

Foreword

Jukka Laaksonen

The operational performance of Finnish nuclear power plants in 2007 shows that the licensees have been successful in ensuring the safety and operational reliability of their power plants. Indicators of both the condition of the plants and the quality of operation developed positively. There were no significant events compromising safety, and the number of component malfunctions affecting operation was very low. Component upgrades and safety system improvements were continued at both power plants based on long-term plans. A number of important projects in terms of nuclear safety were in progress in 2007.
In view of the renewal of operating licences, STUK carried out a comprehensive safety assessment of the Loviisa nuclear power plant, based on which it was able to support the extension of the operating licences until both plant units reach 50 years of age.
In connection with the assessment, it could be verified on the basis of regulatory observations and indicators that a potential negative effect related to ageing is not apparent. This is an indication of functional lifetime management and successful component maintenance. Successful water chemistry has been one of the key factors in maintaining the condition of the components. Plant safety has improved continuously since the commissioning of the plant, thanks to both improved operation and operating procedures and the increased professional skill of the staff. Structural safety has also been developed consistently, first by removing risks identified by means of qualitative examinations, and later by utilising detailed probabilistic risk analysis. The scope of this analysis has been extended and its accuracy improved continuously since the completion of the first version in 1989. The Loviisa power plant has had positive experiences of the quality of Russian nuclear fuel, in particular: no leaking fuel rods have been detected during this millennium.

During the first years of operation, the collective occupational radiation doses at Finnish nuclear power plants were very low in a comparison between nuclear power plants worldwide. Since then, radiation doses have been reduced considerably in other countries, but Finland has not seen a similar development. During 2007, STUK and both of the utilities systematically looked for means to reduce occupational radiation doses and carried out various measures for this purpose. Indeed, occupational radiation doses in 2007 were the lowest in the power plants' history but, due to the short outages and the relatively small amount of work performed during them, it is still premature to conclude that any permanent improvement has taken place in occupational radiation protection.

A generational shift is in progress among the management and expert posts at both of the nuclear power plants. This has been found to proceed without problems, and young motivated employees have been hired to be trained alongside senior personnel sufficiently early in order to ensure the continuity of operation. A new responsible manager was approved for both plants towards the end of the year.

Radioactive waste generated in operational processes at the nuclear power plants accumulated as anticipated. Its processing and final disposal in underground facilities took place in a controlled manner.

STUK's work input in the regulatory control of each of the operating nuclear power plants was equivalent to approximately 10 person-years. The work input has been approximately the same for the past four years, or during the period that most of the regulatory resources have been occupied with the Olkiluoto 3 plant unit under construction. Before the construction project started, some more human resources were used for the regulation of operating plants each year, and the reduction compared with the situation in previous years has been 2–3 person-years for each of the power plants. However, the objectives set for regulation were attained equally as well as before. 29 person-years were used for overseeing the design, component manufacturing and construction of the Olkiluoto 3 unit, or slightly more than previously. The amount of work will continue to increase in 2008 and 2009, which will see a lot of component manufacturing and installation operations. The current financing practice for regulatory operations, i.e. direct invoicing from the licensees according to STUK's actual costs, has proven to function very well, and it has enabled increasing operations according to actual needs.

The repair of the defects in the manufacture of the reactor containment steel liner slowed down the construction of the new plant unit at Olkiluoto. The construction of the containment, which proved more demanding than anticipated, also lagged behind the target schedule. However, the operations at the construction site were organised and managed in a controlled manner, and the quality of completed work was found to be appropriate. Difficulties continued in the manufacturing of a number of structures and components intended for Olkiluoto 3 in compliance with quality standards. Some of these difficulties may delay the completion of the plant unit, but no compromises were made in the quality of approved completed products. The experiences of the regulation of construction further emphasised the importance of comprehensive inspections as a means for ensuring the required quality. The oversight of the operations of the client utility was continued according to the inspection programme that has been in use since the commencement of construction. A systematic approach to inspections has proven to be a good tool for assessing the utility's operations. In order to avoid any delays due to regulatory control, procedures were improved on the basis of the experiences, and contact with the organisations participating in deliveries was intensified.

Three new environmental impact assessments aiming at the construction of nuclear power plants were commenced during the year. STUK reviewed the assessment plans mainly with a view to ensuring comprehensiveness and the correctness of the information provided. At the same time, STUK started to familiarise itself with the possible plant types at the request and cost of the utilities. Preparation is necessary for STUK to be able to promptly present its own safety assessments related to potential decisions-in-principle. As part of the preparation for potential future nuclear facility projects, STUK continued the preparation of the reform of nuclear energy legislation together with the Ministry of Trade and Industry. From the start, the involvement of the users of nuclear energy at all stages of the regulatory reform was emphasised.

Due to the amount of work required for the new nuclear facility projects, an organisational change was planned for the department in charge of nuclear reactor regulation, to be adopted in 2008. Decision-making powers, which have previously mostly been vested with the director, will be assigned to three assistant directors, who will form a new organisational level above the offices.

Posiva Oy continued the construction of the research facility needed for developing the final disposal of spent nuclear fuel by excavating the tunnel leading to the facility and shafts. During 2007, the excavation reached more than half of the final target. STUK oversaw the work, preparing for the possibility that the tunnel and the shafts will in due course lead to the actual final disposal facility. Proving the safety of final disposal will primarily be based on the reliability of the barrier structures preventing the spreading of radioactive substances. These structures will consist of a gas-tight copper canister and surrounding bentonite clay. As the focus of the final disposal project shifted towards technical design and construction, STUK organised its regulatory operations to correspond to the increased amount of work and the changed tasks. At the same time, it hired a number of experts in various fields and intensified the operation of the team of international experts directly supporting the regulatory control.

The reform of the preparation for exceptional radiation situations in Finland, which has required several years' effort, was completed. The automatically alerting radiation monitoring network in Finland is now reliable, very tolerant of individual equipment malfunctions and sufficiently dense. STUK considers it to be the best in the world and implemented in the most cost-efficient manner. The joint actions by the authorities to control a fall-out situation have also been planned under STUK's leadership in a manner that provides an internationally-commended example for other countries, as well. The network required for measuring foodstuffs, composed of municipal and private laboratories, was provided with new equipment, and the staff of these laboratories was trained.

A lot of experiences were gained of nuclear materials regulation according to the amended nuclear non-proliferation agreement and, in particular, of the division of labour between the IAEA, the EU and national regulatory authorities. STUK made an active contribution towards finding an optimal division of labour between the parties concerned and attempted to show the way to achieving well-functioning procedures ensuring an adequate level of confidence. A model for nuclear safeguards suitable for the final disposal of spent nuclear fuel was developed further, in tandem with the excavation of the tunnel leading to the final disposal facility.

1 Fundamentals of nuclear safety regulation

Regulatory control by STUK is based on the Nuclear Energy Act

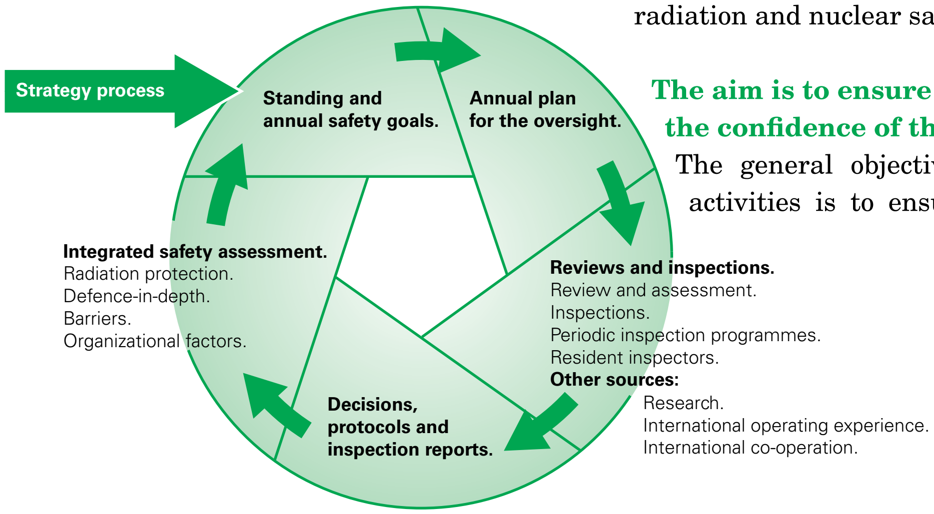
The Radiation and Nuclear Safety Authority (STUK) is responsible for the regulatory control of nuclear safety in Finland. Its responsibilities include the control of physical protection and emergency response, as well as the safeguards of nuclear materials necessary to prevent nuclear proliferation.

STUK lays down detailed requirements concerning nuclear safety

STUK contributes to the processing of applications for licences under the Nuclear Energy Act, controls compliance with the licence conditions, and formulates the detailed requirements. STUK also lays down qualification requirements for personnel involved in the use of nuclear energy and controls compliance with these requirements. In addition, STUK submits proposals for legislative amendments and issues general guidelines concerning radiation and nuclear safety.

The aim is to ensure safety and maintain the confidence of the general public

The general objective of STUK's regulatory activities is to ensure the safety of nuclear



STUK functions for the oversight of nuclear power plants

Oversight of New Plant Projects and Plant Modifications
- Changes at the nuclear facility

Safety Assessments and Analysis
- Deterministic safety analysis
- Probabilistic risk analysis (PRA)
- Safety performance indicators; analysis and feedback

Oversight of Operations
- Compliance with Technical Specifications
- Incidents
- Oversight of outage management
- Maintenance and ageing management
- Fire protection
- Radiation protection
- Emergency preparedness
- Physical protection

Oversight of Management in Regulated Organizations
- Safety management
- Management systems and QM
- Training and qualification of staff
- Use of operational experiences
- Event investigation
- Nuclear liability
- Inspection and testing organisations
- Manufacturers of nuclear pressure equipment

Oversight of Nuclear Waste Management and Nuclear Materials
- Safeguards of nuclear materials
- Nuclear waste management
- Control of radioactive materials transport
- Licences for the nuclear materials and nuclear waste

Figure 1. Oversight of nuclear facilities; from strategy in implementation.

Defence in depth

The safety of a nuclear power plant is ensured by preventing the harmful effects of reactor damage and radiation through successive and mutually-redundant functional levels. This approach is called the defence in depth principle. Safety ensuring functions may be divided into preventive, protective and mitigating levels.

The aim of the preventive level is to prevent any deviations from the plant's normal operational state. Accordingly, high quality standards apply to component design, manufacturing, installation and maintenance, as well as plant operation.

The protective level refers to providing for operational transients and accidents through systems aimed at detecting disturbances and preventing their development into a severe accident.

The mitigating level is needed if the first or second level functions fail to stop the progress of an accident.

In addition to the functional levels, the defence in depth approach includes the principle of multiple successive barriers to potential radioactive releases, and a number of good design and quality management principles.

facilities so that plant operation does not cause radiation hazards that could endanger the safety of workers or the population in the vicinity or cause other harm to the environment or property. The most important specific objective is to prevent a reactor accident that would cause a release of radioactive substances or a threat of a release. Another objective is to maintain public confidence in regulatory activities.

STUK ensures the adequacy of safety regulations and compliance with the requirements

It is STUK's task to ensure in its regulatory activities that safety regulations contain adequate requirements for the use of nuclear energy and that nuclear energy is used in compliance with these requirements and in accordance with a good safety culture.

Regulation by STUK ensures the attainment of safety objectives

The attainment of the objectives laid down in the safety regulations is ensured by means of inspections and reviews. STUK's operations are guided by annual follow-up plans, presenting the key items and activities for inspection and review. STUK reviews plans and the other documentation of nuclear facilities. Various inspections onsite or at suppliers' premises ensure that the plans are carried out in practice. The licensee is obliged to request that STUK reviews certain documents and carries out inspections on-site or at suppliers' premises. In addition to these inspections and reviews, STUK has separate inspection programmes for periodic inspections at operating plants and inspections during construction. STUK also employs resident inspectors at the plants, who supervise and witness the construction, operation and condition of the plant and the operation of the organisation on a daily basis and report their observations to STUK.

STUK ensures by means of inspections and other controls that the operational preconditions and operation of the licensee and its subcontractors and the systems, structures and components of nuclear facilities are in compliance with the regulatory requirements. An overall safety assessment is conducted annually on each nuclear facility, dealing with the attainment of radiation protection objectives, the development of defence in depth, and the operation of organisations constructing or operating nuclear facilities and providing services to them.

STUK evaluates the safety of nuclear facility projects from the application for a decision-in-principle

The construction of a nuclear power plant, intermediate storage for spent fuel and a final disposal facility requires a Government decision-in-principle that the project is in line with the overall good of society. The task of giving a statement on and preparing a preliminary safety assessment of the application for the decision-in-principle is vested with STUK. In connection with the application for the decision-in-principle, the applicant also presents a report on the environmental impact assessment. When an application for a construction or operating licence for a nuclear facility has been submitted to the Government, STUK issues a statement on it and encloses its safety assessment.

STUK regulates the different nuclear facility design and construction stages

STUK regulates the different design and construction stages of nuclear facilities. The most extensive design document is the Safety Analysis Report, which presents the safety analyses proving that the facility complies with the relevant safety requirements. STUK evaluates whether the cases examined in the safety analyses have been appropriately selected, whether the analyses have been conducted correctly and whether their outcomes are acceptable. The purpose of the regulation of nuclear facility construction is to ensure compliance with the conditions of the construction licence and the regulations and approved plans concerning concrete and steel structures, electrical and I&C components and pressure equipment. The requirements apply to all organisations taking part in the project whose activities have an impact on the safety of the nuclear facility.

Regulation of operating plants includes continuous safety assessment.

STUK's regulation of operating nuclear facilities ensures that the condition of the facilities is and will be in compliance with the requirements, the facilities function as planned and are operated in compliance with the regulations. The regulatory activities cover the operation of the facility, its systems, components and structures, as well as the operation of the organisation. In this work, STUK employs regular and topical reports submitted by the licensees, on the basis of which it assesses the operation of the facility and the plant operator's activities. In addition, STUK assesses the safety of nuclear power plants by carrying out inspections on plant sites and at component manufacturers' premises, and based on operational experience feedback and safety research. On the basis of the safety assessment during operation, both the licensee and STUK evaluate the need and potential for safety improvements.

Safety analyses provide tools for assessing the safety of nuclear facilities

Safety analyses ensure that the nuclear facility is designed to be safe and that it can be operated safely. Deterministic and probabilistic approaches complement each other.

Deterministic safety analyses

For the purpose of STUK's regulatory YVL guides, deterministic safety analyses refer to the analyses of transients and accidents required for justifying the technical solutions employed by nuclear power plants. The licensees update these analyses in connection with the renewal of operating licences, periodic safety reviews and any significant modifications carried out at the plant. STUK reviews the analyses submitted by licensees and conducts, or contracts out where necessary, its own reference analyses to ensure the reliability of the results.

Probabilistic risk analyses

Probabilistic risk analysis (PRA) refers to quantitative estimates of the threats affecting the safety of a nuclear power plant and the probabilities of chains of events and any detrimental effects. PRA makes it possible to identify the plant's key risk factors, and can contribute to the design of nuclear power plants and the development of plant operation and technical solutions.

STUK reviews the probabilistic risk analyses related to construction and operating licences and the operation of a nuclear power plant. The licensees employ PRA for the maintenance and continuous improvement of the technical safety of nuclear facilities.

STUK oversees modifications from planning to implementation

Various modifications are carried out at nuclear facilities to improve safety, replace aged systems or components, facilitate plant operation or maintenance, or improve the efficiency of energy generation. STUK approves the plans for the extensive and safety-significant plant modifications and oversees the modification work by reviewing the documents submitted by the licensee and carrying out inspections on-site or at manufacturers' premises.

As a consequence of modifications implemented at the plant, several documents change that describe the plant's operation and structure – such as the Technical Specifications, the Final Safety Analysis Report and the operating and maintenance procedures. STUK supervises the document revisions and generally follows the updating of plant documentation after the modifications.

Oversight of plant operability

The technical operability of nuclear facilities is overseen by assessing the operation of the facility in compliance with the requirements laid down in the Technical Specifications, and following annual maintenance outages, plant maintenance and ageing management, fire safety, radiation safety, physical protection and emergency preparedness.

Technical specifications

The Technical Specifications of nuclear facilities lay down the detailed requirements and restrictions concerning the plant's various systems and components. The licensee is responsible for keeping the Technical Specifications up-to-date and ensuring compliance with them. STUK controls compliance with the plants' Technical Specifications by witnessing operations on-site. Special attention is paid to the testing and fault repairs of components subject to the Technical Specifications.

When annual maintenance outages end, STUK ascertains the plant unit's state in compliance with the Technical Specifications prior to start-up. Any changes to and planned deviations from the Technical Specifications must be submitted to STUK for approval in advance. In addition, the licensee is responsible for reporting to STUK without delay all situations deviating from the requirements under the Technical Specifications. In the report, the utility presents its corrective action for approval by STUK. STUK controls the implementation of corrective action in periodic inspections, for example.

Reporting

Licensees submit event reports to STUK on operational events at nuclear facilities, comprising special reports, operational transient reports and scram reports. In addition to event reports, the facilities submit daily reports, quarterly reports, annual reports, outage reports, annual environmental safety reports, monthly individual radiation dose reports, annual operational experience feedback reports and safeguards reports to STUK.

Annual maintenances

The annual maintenances at nuclear facilities comprise refuelling, preventive maintenance, periodic inspections and testing, as well as fault repairs – work that cannot be performed during operation. These actions ensure the preconditions for operating the power plant efficiently and safely during the next operating cycles.

STUK is responsible for controlling and ensuring that the nuclear power plant is safe during the annual maintenance and the future operating cycles and that the annual maintenance does not cause a radiation hazard to the workers, the population or the environment. STUK ensures this by reviewing the documents required by the regulations, such as outage plans and modification documentation, and by performing on-site inspections during annual maintenance.

Ageing management

In its regulatory activities concerning the ageing management of operating nuclear facilities, STUK controls that the plants' ageing management strategy and its implementation ensures the maintenance of sufficient safety margins for safety-significant systems, components and structures throughout their lifetime. The organisation of the licensee's operations, the prerequisites for the organisation to carry out the necessary actions, and the condition of components and structures important to safety are subject to inspections and

__Radioactive releases from a nuclear power plant__ into the air and sea are precisely measured at the plant. The measurement results are verified by comprehensive environmental radiation monitoring. Radiation monitoring in the environment of a power plant comprises radiation measurements and determination of radioactive substances, conducted to analyse the radioactive substances existing in the environment. In case of potential accident situations, continuously-operating radiation measurement stations monitoring the external radiation dose rate are installed in the vicinity of nuclear power plants at distances of a few kilometres. The measurement data from these stations are transferred to the power plant and to the national radiation-monitoring network.

reviews. Regulatory control ensures that the utilities have the lifetime management programmes in place that enable them to detect potential problems in time. In addition, corrective action must be carried out in a way that ensures the integrity of safety-significant components and structures and the operability of safety functions throughout the plant's lifetime.

Radiation safety

STUK oversees occupational radiation safety by inspecting and reviewing dosimetry, radiation measurements, radiation protection procedures, radiation conditions and radiation protection arrangements for work processes at each facility. In addition, STUK oversees the meteorological dispersion measurements of radioactive substances, release measurements and environmental radiation monitoring, and also reviews the relevant result reports.

Oversight of organisational operation

STUK oversees the operation of organisations by reviewing safety management, the management and quality systems, the competence and training of the staff of nuclear facilities and operational experience feedback activities. The aim is to ensure that the organisations of the utility as a whole and its key suppliers operate in a manner that ensures the safety of the plant at all levels and in connection with safety-related actions.

Operational experience feedback

According to Government Decision 395/1991, the advancement of science and technology and operating experiences must be taken into account for the further enhancement of the safety of nuclear power plants. This principle is not limited to operational experiences from Finnish nuclear power plants, but feedback from abroad must also be analysed systematically, and action must be taken to improve safety as necessary. STUK controls and ensures that the utilities' operational experience feedback activities effectively prevent the reoccurrence of events. STUK pays particular attention to the utilities' ability to detect and identify the causes of the events and to remedy the underlying operational weaknesses. In addition, STUK analyses Finnish and foreign operational experience data and, as necessary, lays down requirements to enhance safety.

Event investigations

An event investigation team is appointed when the licensee's own organisation has not operated as planned during an event or when the event is estimated to lead to significant modifications to the plant's technical layout or procedures. A STUK investigation team is also set up if the licensee has not adequately clarified the root causes of an event.

Inspection and testing organisations

In addition to regulating the design and manufacturing of pressure equipment, STUK oversees the operational safety of pressure equipment included in the most important safety classes and performs periodic inspections of such equipment. The pressure equipment of other safety classes is inspected by inspection organisations authorised by STUK. STUK oversees the operation of the manufacturers and testing and inspection organisations authorised by it in connection with its own inspection activities and by reviewing documents and making follow-up visits.

Nuclear liability

The Nuclear Liability Act stipulates that users of nuclear energy must have acquired liability insurance or other financial guarantee for a possible accident at a nuclear facility that would harm the environment, population or property. Fortum Power and Heat Oy and Teollisuuden Voima Oy have prepared for damage from a nuclear accident as prescribed by law by taking out an insurance policy for this purpose, mainly with the Nordic Nuclear Insurance Pool.

In case of an accident, the funds available for compensation come from three sources: the licensee, the country of location of the facility and the international liability community. In 2007, a total of 300,000,000 SDR was available for compensation from these sources. SDR refers to Special Drawing Right, an international reserve asset defined by the International Monetary Fund (IMF), whose value is based on a basket of key international currencies. In 2007, the average value of SDR was 1.12 euro. As a result of international negotiations completed in 2004 concerning the renewal of the Paris/Brussels nuclear liability agreements, funds available for compensation will be more than tripled compared with the current situation in the near future. Finland has also decided to enact a law laying down unlimited licensee liability. The legislative amendment has not taken effect as yet, but is pending the entry into force of the relevant international agreements.

The ascertaining of the contents and conditions of a licensee's insurance arrangements in Finland belongs to the Insurance Supervisory Authority. It has approved both Fortum Power and Heat Oy's and Teollisuuden Voima Oy's liability insurance, and STUK has verified the existence of the policies as required by the Nuclear Energy Act.

The Nuclear Liability Act also covers the transport of nuclear materials. STUK has ascertained that all nuclear material transport has had liability insurance approved by the Insurance Supervisory Authority or in accordance with the Paris Convention and approved by the authorities of the sending state.

Nuclear safeguards are a basic requirement for using nuclear energy

Nuclear safeguards ensure that nuclear materials and other nuclear commodities remain in peaceful use in compliance with the relevant licenses and notifications. STUK reviews applications for licences concerning nuclear materials and other nuclear commodities, and maintains the national safeguards system. Licensees are responsible for managing the nuclear materials in their possession, accounting for them and reporting any changes to STUK and the European Commission. Some of the data is forwarded to the IAEA. STUK verifies the correctness of the licensees' accounting and reporting through on-site inspections carried out by STUK alone or together with international inspectors.

STUK's regulatory oversight extends from design to final disposal

The aim of the regulation of nuclear waste management is to ensure that nuclear waste is processed, stored and disposed of safely. The control of nuclear waste processed at plant sites is part of the regulatory control of operating plants mentioned above. In addition, STUK approves the clearing of waste from control and reviews plants' nuclear waste management and decommissioning plans, on the basis of which the licensees' nuclear waste management fees are determined.

During the past few years, the final disposal project for spent fuel has required special attention. STUK has reviewed Posiva Oy's project implementation plans and overseen the construction of an underground research tunnel called Onkalo at Olkiluoto. Onkalo is also used for testing suitable working methods for the final disposal facility and mapping the underground premises. The aim is for Onkalo to later become one of the main entrances of the final disposal facility.

Advisory Committee on Nuclear Safety

Pursuant to the Nuclear Energy Act, the preliminary preparation of matters related to the safe use of nuclear energy is vested with the Advisory Committee on Nuclear Safety. It is appointed by the Government and functions in conjunction with

STUK. Its term of office is three years. The Advisory Committee was appointed on 1 October 2006, and its term of office ends on 30 September 2009.

The Chairman of the Committee is Professor Riitta Kyrki-Rajamäki (Lappeenranta University of Technology) and the Vice-Chairman Rauno Rintamaa, Vice President, Business Solutions (VTT, Technical Research Centre of Finland). The members are Director Ulla Koivusaari (Pirkanmaa Regional Environment Centre), Managing Director Timo Okkonen (Inspecta Tarkastus Oy), Senior Researcher Ilona Lindholm (VTT), Branch Manager Runar Blomkvist (the Geological Survey of Finland) and Dr. Sc. (Tech.) Antti Vuorinen. Professor Jukka Laaksonen, Director General of STUK, is a permanent expert to the Committee.

The Committee convened 11 times during the year. The year was an active one in the sphere of legislation and regulations: the Committee heard STUK's experts on the reform of nuclear energy legislation and the revised YVL guide system. The Committee issued statements to STUK on a total of 10 different draft acts and decrees. It prepared statements to STUK on two YVL guides under revision. The preparation of statements on three other draft YVL guides was initiated. In addition, the Committee regularly followed the progress of the construction of the Olkiluoto 3 plant unit, the operational events at the operating nuclear facilities and participated, together with the Advisory Committee on Nuclear Energy, in the organising of an annual nuclear energy seminar. Furthermore, the Committee prepared statements on Posiva's research plan for 2008 concerning nuclear waste management and the fourth international report under the Convention on Nuclear Safety.

The Committee convened once at the Loviisa nuclear power plant, acquainting itself with topical safety issues at the Loviisa plant and key issues in terms of the renewal of its operating licence. The Committee issued a statement to STUK on the application for the operating licence. The Committee also visited the construction sites of the new unit at Olkiluoto and the underground research facility Onkalo of the nuclear waste repository. On both visits, the Committee heard presentations by the licensees' experts concerning safety issues and the progress of the projects.

The Committee has three divisions for preparatory work: a Reactor Safety Division and a Nuclear Waste Division, as well as an Emergency Preparedness and Nuclear Material Division. In addition to the Committee members proper, distinguished experts from various fields have been invited to the Divisions. A total of sixteen Division meetings were held in 2007.

2 Objects of regulation

Loviisa nuclear power plant

Plant unit	Start-up	National grid	Nominal electric power, (gross/net, MW)	Type, supplier
Loviisa 1	8 Feb 1977	9 May 1977	510/488	PWR, Atomenergoexport
Loviisa 2	4 Nov 1980	5 Jan 1981	510/488	PWR, Atomenergoexport

Fortum Power and Heat Oy owns the Loviisa 1 and 2 plant units located in Loviisa.

Olkiluoto nuclear power plant

Plant unit	Start-up	National grid	Nominal electric power, (gross/net, MW)	Type, supplier
Olkiluoto 1	2 Sep 1978	10 Oct1979	890/860	BWR, Asea Atom
Olkiluoto 2	18 Feb 1980	1 Jul 1982	890/860	BWR, Asea Atom
Olkiluoto 3	Construction licence granted 17 Feb 2005		about 1,600 (net)	PWR, Areva NP

Teollisuuden Voima Oy owns the Olkiluoto 1 and 2 plant units located in Olkiluoto, Eurajoki, and the Olkiluoto 3 plant unit under construction.

Onkalo

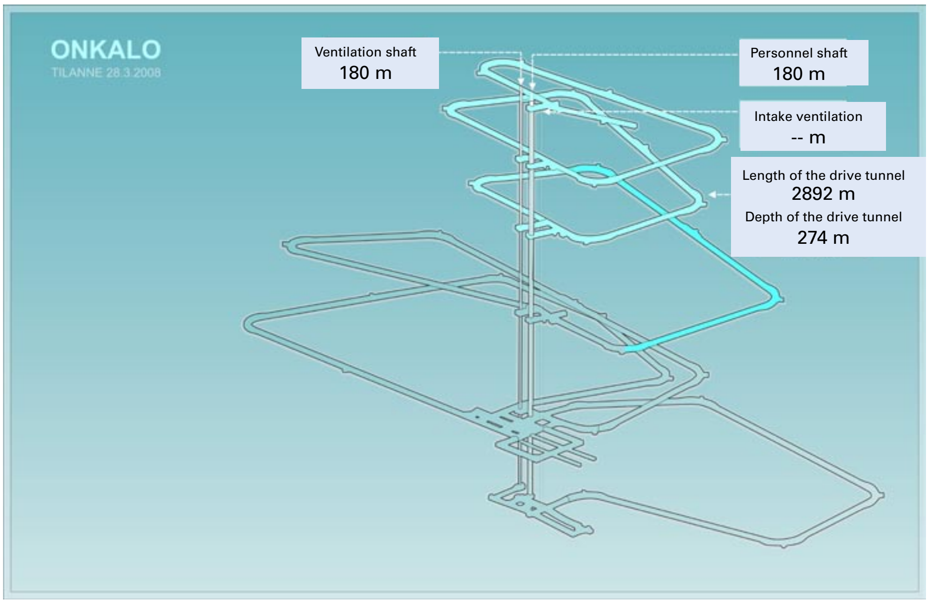


Figure 2. Plan of the underground rock characterisation facility (Onkalo) and status of the construction on 28 March 2008.

Posiva Oy is constructing an underground rock characterisation facility (Onkalo) in Olkiluoto, where bedrock volumes suitable for final disposal of spent nuclear fuel can be investigated in more detail. Bedrock research at the planned final disposal depth is a requirement for granting a construction licence for the final disposal facility. Posiva has designed Onkalo to function as one of the entrance routes to the planned final disposal facility, so STUK applies the same regulatory procedures to the construction of Onkalo as that of a nuclear facility.

The underground research facility consists of a drive tunnel, three shafts and research galleries at the depths of 420 m and 520 m. Posiva started constructing Onkalo in 2004. At the end of 2007, the excavation of the drive tunnel had reached the depth of 250 m, and the length of the tunnel was 2,600 m. In addition, excavation by raise boring had reached the depth of 180 m.

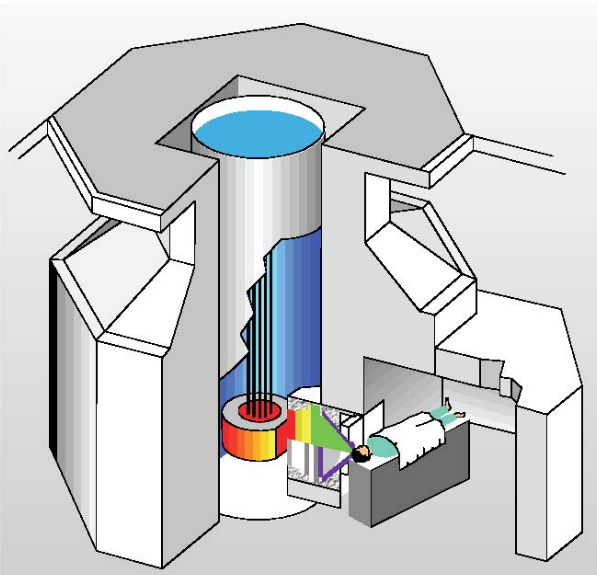


Figure 3. FiR 1 research reactor and the BNCT station.

FiR 1 research reactor

In addition to nuclear power plants, STUK regulates the FiR 1 research reactor operated by VTT Technical Research Centre of Finland. The reactor is located in Otaniemi, Espoo, and its maximum thermal power is 250 kW. It began operation in March 1962, and its current operating licence will expire at the end of 2011. The reactor is used for production of radioactive tracers, activation analysis, student training and Boron Neutron Capture Therapy (BNCT) treatment of tumours, as well as the development of therapeutic methods.

- TRIGA Mark II research reactor
  Thermal power 250 kW
- Fuel of the core:
  80 fuel rods with 15 kg uranium
  TRIGA reactors have a unique
  fuel type;
  uranium–zirconium hybrid combination
  8% uranium
  91% zirconium
  1% hydrogen

3 Development and implementation of legislation and regulations

Legislative proposals have been prepared and the necessary statements submitted

STUK has contributed to the preparation of the legislative project under the Ministry of Trade and Industry, aiming at the amendment of the Nuclear Energy Act[1], the Nuclear Energy Decree[2], and Government Decisions[3]. The project brings statutes, most of which are 16 years old, up-to-date. In addition, the status of the regulations in the legal system is brought in line with the new Constitution that took effect in 2000.

The reform of the nuclear energy legislation has proceeded to a stage where the statutes will be implemented. The Government Bill on the amendment of the Nuclear Energy Act is being debated in Parliament committees. The amended Nuclear Energy Decree and four new Government decrees are being finalised at the Ministry of Trade and Industry.

The amendments to the Nuclear Energy Act will be debated in Parliament in 2008. The Nuclear Energy Decree and other Government decrees can be implemented after the Nuclear Energy Act has been passed. STUK submitted its statement on the decrees in question to the Ministry of Trade and Industry in December 2007, enclosing the statement of the Advisory Committee on Nuclear Safety.

Updates of YVL guides have been prepared and implemented

STUK prepared the last updates of the YVL guides in their current form and issued decisions on their implementation. YVL guides are detailed safety regulations for nuclear facilities, issued by STUK on the basis of the Nuclear Energy Act and the relevant Government Decision. The guides describe STUK's regulatory procedures as well. STUK issues a separate decision on how a new or revised YVL guide applies to operating nuclear facilities, or those under construction and to licensee operations.

No new YVL guides were completed in 2007, but the work on all of the guides being processed proceeded so that they can be implemented before the entry into force of the Government decrees.

In the application decision for Guide YVL 1.1, STUK specified for Teollisuuden Voima Oy when the following plant documents delivered to STUK for approval can be adopted:

- The Probabilistic Risk Assessment (PRA) can be adopted after it has been approved according to the licensee's internal procedure and delivered to STUK for approval.
- The Final Safety Analysis Report (FSAR) can be adopted after delivery to STUK to the extent that the changed data have been approved by STUK separately.
- Amendments to the classification document must be approved by STUK prior to adoption.

In the implementation decision for Guide YVL 3.3, STUK required document updates by the Loviisa nuclear power plant, such as those related to up-

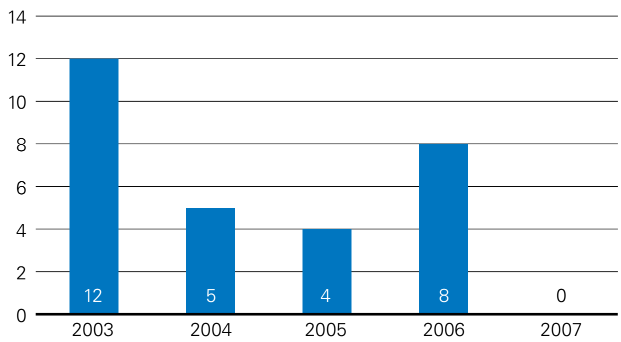


Figure 4. Number of yearly published YVL guides.

1 990/1987
2 161/1988
3 395–398/1991, 478/1999

Table 1. Implementation decisions of previously published YVL guides issued by STUK per nuclear facility in 2007.

Guide	Loviisa 1&2	Olkiluoto 1&2	Olkiluoto 3	FiR 1 research reactor
YVL 1.1, Regulatory control of safety at nuclear facilities, 10 Feb 2006	•	•	•	•
YVL 3.3, Pipings at nuclear facilities, 26 Jun 2006	•	•	•	
YVL 7.1, Limitation of public exposure in the environment of and limitation of radioactive releases from a nuclear power plant, 22 Mar 2006	•	•	•	
YVL 7.6, Monitoring of discharges of radioactive substances from a nuclear power plant, 22 Mar 2006	•	•	•	
YVL 7.7, Radiation monitoring in the environment of a nuclear power plant, 22 Mar 2006	•	•	•	
YVL 7.8, Environmental radiation safety reports of a nuclear power plant, 22 Mar 2006	•	•	•	
YVL 7.11, Radiation monitoring systems and equipment of a nuclear power plant, 13.7.2004*			•	

*The implementation of Guide YVL 7.11 for operating nuclear facilities has been decided in 2005.

date notes to be recorded in plant documentation. STUK approved the interpretations presented by Teollisuuden Voima Oy concerning the application of the guide at the Olkiluoto nuclear power plant. Approval required specifications to the utility's guidelines, such as those ensuring the preconditions for regulation by STUK.

In the implementation decision for Guide YVL 7.1, STUK required that the utilities deliver an assessment of the containment of radioactive releases using the best available technology and update the descriptions in the Safety Analysis Report.

In the decision issued to Fortum Power and Heat Oy on the application of Guide YVL 7.6, STUK pointed out that, according to the guide, the laboratory analyses of releases must be carried out at laboratories that comply with the requirements of appropriate standards. STUK required that an independent evaluation of the laboratory at the Loviisa nuclear power plant be conducted in view of applicable standards. Furthermore, STUK required that the utility updates the description of the release routes of gaseous substances, included in the Safety Analysis Report. In the decision issued to Teollisuuden Voima Oy, STUK required that that the radioactive iodine and aerosol releases through the exhaust gas pipe must be measured using a fixed, continuously operating radiation measurement system. This requirement must be met in connection with the upgrade of radiation measurement systems in progress at the Olkiluoto plant.

The revision of YVL guides is progressing

The structural revision of the YVL guides was initiated in 2005 by assessing the existing guides and defining the development objectives. The overall objective is to improve the internal consistency of the guides and, in particular, clarify the requirements laid down in the guides. The requirements will be numbered to make it easier to find the individual requirements in the guides and to control compliance with them. This will also enable amending the guides with regard to individual requirements.

The overall revision will be implemented in four stages. Higher-level and system-level guides will be prepared at the initial stage, and the next stages will cover the revision of component-level guides. The objective is to have the new set of STUK-YVL guides completed by the end of 2011.

Working groups composed of representatives of Finnish nuclear utilities and VTT, the Technical Research Centre of Finland, have been set up to support STUK's experts in the preparation of each new guide. The working groups will discuss the main content of the guides during their preparation, thus reducing the overall period of time spent in their preparation. The follow-up group set up for the entire project, composed of representatives of STUK, the utilities and VTT, convened two times in 2007.

The preparation of five guides of the new type, started the previous year, was continued in 2007. Experiences of the preparation of the first guides will be compiled during the spring of 2008. In addition, the preparation of a number of new guides was planned to begin in 2007. Preliminary drafts of these guides were prepared. The plan according to the preparatory procedure for STUK guides was drawn up for four guides.

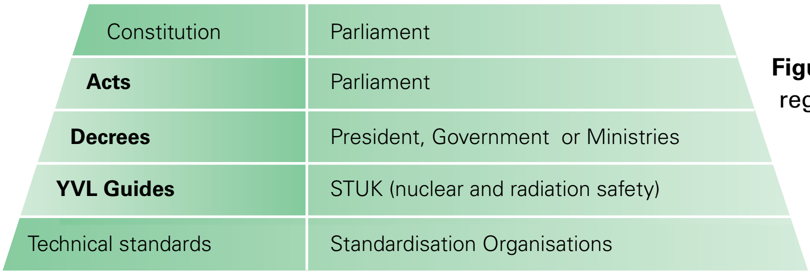


Figure 5. The hierarchy of the nuclear safety regulations.

4 Nuclear facilities' regulation and regulation results in 2007

4.1 Loviisa nuclear power plant

4.1.1 Overall safety assessment of the Loviisa NPP

The Loviisa plant units were operated safely in 2007

In 2007, the safety of the Loviisa plant was subject to more intensive and extensive assessment than usual due to the renewal of the plant's operating licence. STUK reviewed the safety review drawn up by the licensee, which included an evaluation of the plant's condition and operation during the previous licence term and an estimate on the development of the plant's condition and its operating organisation during the next licence term. According to STUK's assessment, the facility is safe and operated well, based on which it supported the extension of the operating licence.

The condition of the multiple barriers containing releases of radioactive substances has remained good. There were no leaking fuel rods at the plant in 2007. A significant follow-up item that has an impact on the integrity of the reactor pressure vessels at both plant units is the tightness of the corrosion protection pipes in the penetrations of vessel heads. No indications of deterioration were observed in the inspections of the reactor pressure vessel and piping performed during the annual maintenance outages at the plant units. The results of annual tests prove that the leak-tightness of the containment and isolation valves has remained good.

Plant operation has been systematic and in compliance with the Technical Specifications and guidelines, with two exceptions. The condition of components and systems designed to prevent accidents and mitigate their impact has remained good. The number of component failures has been low. No indications of deterioration in the condition of components were detected in periodic tests and preventive maintenance. The number of events was low and their risk significance slight. The safety systems have functioned as planned during events. The safety significance of operational transients and detected component failures was low.

The accident risk at the Loviisa power plant has reduced and risk factors have been eliminated effectively. In 2007, a new seawater line was completed that enables alternatively taking the sea water necessary for cooling the plant during shutdown from the discharge channel. This modification significantly reduces the risk in situations where algae, frazil ice or an oil spill could endanger the normal intake of sea water.

The Loviisa plant employs an ageing management programme aimed at guiding the maintenance and modifications at the entire plant so that the plant can be used safely throughout is lifetime. Investments have been continued according to long-term plans. During the year, the management of spare parts was found to require development. Most of the Loviisa I&C system upgrade work was postponed to 2008, but preparatory construction and installations were carried out at the plant.

Plant operation did not cause a radiation hazard to workers, the population or environment. Occupational radiation doses and radioactive releases into the environment were low and clearly below authorised limits. Emergency preparedness at the Loviisa power plant is in compliance with regulatory requirements. The functionality of the emergency response was tested during an emergency exercise organised at the end of November.

The Loviisa power plant has developed its quality assurance system on a long-term basis. The system is mostly functional and comprehensively regulated. Observations made during the year indicate that the Loviisa power plant must continue to develop its procedures related to operational planning, monitoring of the attainment of objectives, the working environment, and monitoring of the implementation of modification projects and their schedules.

Human resource planning at the Loviisa power plant is based on a ten-year plan, which is subject to annual management review and updating. About 50 new staff were recruited at the plant in 2007. Attention must still be paid to the sufficiency of personnel resources in duties important to nuclear safety, such as quality control, quality assurance, risk assessment and radiation protection. Personnel training activities at the Loviisa power plant have been organised appropriately. However, the implementation of the familiarisation programmes for new personnel and persons changing duties must be developed.

4.1.2 Oversight and observations

Operating licence

In its statement, STUK supported the extension of the Loviisa plants' operating licence.

To prepare for the statement submitted to the Ministry of Trade and Industry, STUK conducted a safety assessment on the Loviisa nuclear power plant, based on STUK's inspections and reviews of the issues and documents related to the operating licence application, a review of the applicant's own safety review and the results of oversight. STUK requested a statement from the Ministry of the Interior on emergency preparedness and physical protection, and a statement from the Advisory Committee on Nuclear Safety on STUK's draft statement.

STUK started the review of documents in 2006, and the work was continued in 2007 according to a predefined schedule. The key areas for review comprised lifetime management, plant safety, safety analyses, issues related to plant operation and the safety culture, as well as environmental and nuclear waste-related issues. On the basis of STUK's observations, the applicant supplemented the documentation during the spring of 2007.

Based on the existing licences granted by STUK, the reactor pressure vessels may continue to be used at Loviisa 1 and Loviisa 2 until 2012 and 2010, respectively. Further use requires renewed licences, but there are no foreseeable obstacles for the continued use of the reactor pressure vessels after the expiry of the current licences. If necessary, the reactor pressure vessel can be annealed at spots subject to embrittlement due to neutron radiation. The time for the potential annealing will be determined on the basis of analyses.

Safety enhancements must be continued during the new operating licence term. For example, the risk arising from primary circuit coolant leaks directly outside the containment must be reduced. Improvements aimed at preventing reactor coolant

Extending the lifetime of the Loviisa nuclear power plant *by 20 years from the original design base is based on the assessments made within the lifetime management programme. The lifetime management programme and the related know-how have been developed actively and systematically at the Loviisa power plant. From the perspective of lifetime extension, it is essential that the plant has in place adequate procedures to ensure that the condition of the plant has been investigated in depth and that the phenomena related to ageing can be identified early enough. The fatigue analyses of components imposing limits on the plant's lifetime have been updated to correspond with the 50-year lifetime. Since the first years of operation, a number of improvements have been implemented at both units to reduce the risk of embrittlement in the reactor pressure vessel due to neutron radiation. The strength of the reactor pressure vessel is controllable over the 50-year lifetime.*

The design bases concerning the Loviisa nuclear power plant were mostly laid down during the 1970s. The objective during the operation of the plant has been to continuously improve plant safety. Substantial modernisations have been carried out at the Loviisa nuclear power plant since its commissioning, and extensive modifications have been implemented in several systems. Examples of improvements implemented in areas identified through probabilistic risk analysis during the past operating licence term include securing the cooling of main coolant pump seals was well as improvements to the plant's residual heat removal and emergency cooling systems. In addition, modifications were implemented in the containment systems to improve control of severe reactor accidents.

pump seal leaks shall be continued in view of fire and flood situations. Precautions against potential oil accidents in the Gulf of Finland must be further improved by, e.g. developing the emergency preparedness for oil-combating in the neighbouring area and the instructions relating to outage situations. In order to decrease the possibility of a reactivity accident, the accidental flow of unborated coolant into the primary circuit must be more reliably prevented. The risks arising from heavy load lifting must be further reduced by improving the structural reliability of the crane and developing the procedures relating to lifting. The licensee has presented a long-term plan for reducing the accident and release risk, and for supplementing the existing Probabilistic Risk Assessment. STUK oversees the implementation of the programme.

According to STUK's assessment, Fortum Power and Heat Oy aims to maintain an advanced safety culture. However, the safety culture could be advanced in a more systematic manner with the support of experts in organisational research. STUK will follow the development of the safety culture. Attention will be paid to the sufficiency of personnel at the Loviisa power plant during the new operating licence term. The utilisation of operational experience feedback to improve safety should also be improved.

The assessment pertaining to the extension of the operating licences for the Loviisa plant units was carried out on the basis of currently valid legislation. The nature of the planned amendments to nuclear energy legislation is such that they would not have affected the conclusions of the assessment.

STUK's statement was completed on 5 July 2007, and STUK supported the extension of the Loviisa nuclear power plant's operating licence. According to STUK's judgment, continued operation at Loviisa is safe and in compliance with statutory requirements. In its statement, STUK remarked that two periodic safety reviews of the Loviisa nuclear power plant are due during the next licence term. The first one must be submitted to STUK for approval by the end of 2015, and the second by the end of 2023. Extensive plant modifications and safety improvements will be implemented at the beginning of the new licence term. STUK considered it important that the first overall safety assessment should be conducted soon afterwards.

The operating licence granted to the Loviisa plant units extends their lifetime until the age of 50 years.

The previous operating licence of the Loviisa nuclear power plant was valid until 31 December 2007. On 1 November 2006, Fortum Power and Heat Oy submitted an application to the Ministry of Trade and Industry to extend the operating licence for Loviisa 1 until the end of 2027 and for Loviisa 2 until the end of 2030. The terms applied for meant adding 20 years to the plants' lifetime, resulting in an aggregate energy-generating life of more than 50 years for each plant unit. The Ministry of Trade and Industry requested a statement on the application from STUK, among others. At the same time, the utility submitted to STUK the reports according to section 36 of the Nuclear Energy Decree and the periodic safety review according to Guide YVL 1.1.

On 26 July 2007, the Government granted operating licences for the Loviisa plant units, covering the terms Fortum Power and Heat had applied for. The licence conditions include the requirement that the licensee must submit periodic safety reviews to STUK by the end of 2015 and 2023. STUK's statement, the safety assessment, the review of the documents according to section 36 of the Nuclear Energy Decree and the statement of the Advisory Committee on Nuclear Safety are available on STUK's website at www.stuk.fi.

Assessment of safety analyses

Deterministic safety analyses

In connection with the renewal of the operating licence, the licensee has reviewed all of the analyses of transient and accident situations at the Loviisa nuclear power plant and revised them to the extent required on the basis of modifications carried out at the plant or amendments to regulatory requirements. Since the previous operating licence was granted, STUK has revised the guidelines defining the classification of initiating events on the basis of frequency, providing instructions for conducting the analyses and laying down acceptance criteria for the analyses. The adoption of new procedures for transient and accident situations at the Loviisa plant in 2006 is one of the changes resulting in the need to revise the accident analyses.

The analyses discuss anticipated operational transients and postulated accidents used as the design basis of the safety systems, as well as so-called severe accidents. All initiating events have been classified into these classes on the basis of their frequency. Each class contains a variety of transient and accident sequences, and separate analyses have been presented for each. All safety-critical analyses include sensitivity analyses, often of considerable scope.

STUK verified the analyses submitted by the licensee, and the methods used in them. In order to ascertain the reliability of the results, STUK commissioned independent comparative analyses of the most significant safety-related events at the Loviisa plant units. These analyses also included safety analyses, required for assessing the uncertainties relating to calculating methods and assumptions.

On the basis of the verifications carried out by STUK and the analyses commissioned, the results of the deterministic analyses revised by the licensee fulfil the acceptance criteria presented in the revised guidelines.

In connection with the licence renewal, the licensee has also prepared a plan on actions aimed at further enhancing the safety of the plant units in the future, necessitating a revision of the analyses. The most significant upgrade at the Loviisa nuclear power plant during the next few years is the I&C upgrade, which entails an update of almost all of the analyses of transient and accident situations. STUK followed the implementation of these plans during 2007.

Probabilistic risk analyses

Fortum Power and Heat Oy submitted the revised Probabilistic Risk Analysis (PRA) of the Loviisa nuclear power plant for the processing of the operating licence application to STUK. The analysis has been developed and supplemented with regard to flood and weather events during power operation and the modelling of fires and seismic events. The calculation of releases into the environment has been made more specific by revising the model for the migration of radioactive substances. The supplemented analysis also includes a preliminary estimate on the risk of a radioactive release during outage situations. According to STUK's observations, however, the outage risk analysis must be specified further.

The risks of power operation and annual maintenance outages are of the same order of magnitude. During power operation, the most significant risk factors comprise breaks in the control rod drive mechanism cooling system and reactor coolant pump seal leaks. During an annual maintenance outage, the most significant risks include 1) dropping of a heavy load in the reactor building, 2) a sudden increase in reactor power if unborated cooling water is accidentally fed into the reactor, and 3) introduction of oil into the plant's sea water channel due to a shipping accident.

On the basis of the review, STUK required the utility to present a plan to reduce the plant's risks. Safety improvements presented in the utility's plan include: 1) improved reliability of break isolation in the control rod drive mechanism cooling piping, 2) securing the control of reactor coolant pump seal leaks in fire situations, 3) installation of on-line boron analysers to prevent the feeding of unborated water, 4) improving the procedures and equipment used for heavy load lifting, and 5) the further development of guidelines for oil risk situations. Significant upgrade projects are under way at the plant (e.g., the I&C upgrade project LARA), whose implementation will improve safety. The majority of the modifications will be implemented in 2008–2010.

The utility also presented a plan for supplementing the analyses. The outage risk analysis will be specified further in 2008–2009, and the development of outage instructions based on the analysis will be completed in 2012–2015.

Oversight of plant modifications

The I&C systems of the Loviisa power plant will be upgraded

The most important plant modification project at the Loviisa plant is the upgrade of the I&C systems of the plant units. The project started in 2004 with the construction of a new I&C building, and the project is to be completed in 2014.

According to the plan, the upgrade will be implemented phase by phase so that each upgraded system section will be available for commissioning during annual maintenance outages. The first phase was intended to be implemented at Loviisa 1 during the 2007 annual maintenance, comprising the upgrade of the I&C of reactor power limitation and control rod control. However, the construction of the buildings for the new I&C system was delayed, which resulted in delays concerning the buildings' air conditioning and electrical installations, for example. STUK's review in 2007 further showed that the plans for the first-phase I&C upgrade were not fully acceptable, and part of the necessary documentation could not be submitted to STUK on schedule. Therefore, the first phase could not be installed and commissioned at Loviisa 1, and was postponed to 2008. Preparatory construction and installations for 2008 were carried out in 2007. STUK witnessed the installations in connection with the oversight of annual maintenance.

The postponement of the first-phase I&C upgrade modifications at Loviisa 1 will delay the schedule for the next phases of the upgrade.

Refuelling machines will be modernised

Fortum Power and Heat has begun planning the modernisation of refuelling machines at Loviisa 1 and Loviisa 2. The aim of the modernisation is to improve occupational safety and upgrade the I&C and electrical systems. The bridge of the refuelling machine will be made higher, which will enable the refuelling machine to move over the permanent safety railings to be constructed around the fuel pool. In 2007, the utility presented the conceptual design of the refuelling machine to STUK and submitted documentation concerning the safety functions and safety classification to STUK for approval.

Pre-operational testing of the waste solidification facility continued

A solidification facility for liquid radioactive waste has been constructed on the Loviisa plant site. The solidification facility processes the evaporation residues generated at the power plant and the radioactive ion exchange resins from the purification filters. The aim is for, in the first phase, normal operation to begin with the solidification of evaporation residues. The utility continued facility-level pre-operational tests within the solidification facility implementation project (LOKIT), which started in 2006. STUK reviewed the solidification facility test programmes and their results according to the follow-up plan. After an inspection of the radiation protection arrangements, STUK gave permission to continue the tests with radioactive liquid evaporation residues and witnessed the tests. Needs for improvement, such as those concerning level measurements, were observed during the tests, due to which the tests will be carried out again in 2008 once the measurements function reliably.

Intake of cooling water is being ensured through modifications

A project to ensure shutdown reactor cooling (the ESCO1 project) is under way at the Loviisa plant. The project includes the construction of an alternative seawater intake route from the east side of the plant site. The new water intake alternative can be used, for example, if a large oil spill or a bed of algae prevents the operation of normal water intake on the west side. At the end of 2007, the new seawater intake route was completed at Loviisa 1 and the construction of a new route at Loviisa 2 was in the final stages. In addition, an oil combating plan for the new water intake site is necessary in case of threatening oil damage situations.

The importance of preparing for oil hazards has become emphasised during the past few years as oil transports in the Gulf of Finland have increased significantly. In its safety assessment related to the operating licence renewal for the Loviisa power plant, STUK paid attention to the fact that the implementation of an alternative water intake and the preparation of an oil combating plan have been delayed compared with the approved schedules. STUK has requested the Loviisa power plant to submit a description of the oil combating arrangements at the power plant. The description must cover the alerting arrangements, the available equipment, the locations for oil booms, the arrangements for co-operation with the Finnish Environment Institute and the regional fire and rescue services, as well as training and instructions.

Oversight of plant operability

Compliance with the Technical Specifications

STUK controlled compliance with the Technical Specifications at the Loviisa power plant by witnessing operations on-site. Specific areas of control included the testing and repair of components subject to the Technical Specifications. After the completion of the annual maintenances at Loviisa 1 and 2, STUK verified the state of the plant units in compliance with the Technical Specifications and that the Technical Specifications had been appropriately updated before giving permission for start-up.

Table 2. Events at the Loviisa plant units subject to special reports by the utility. The table shows events due to which the plant unit was in non-compliance with the Technical Specifications. All events subject to reporting are discussed in Appendix 1 (indicator A.II.1). Appendix 3 describes events subject to special reports in more detail.

Event	Non-compliances with the Technical Specifications	Special report	INES rating
Power-failure of diesel-backed switchgears at Loviisa 1	•	•	0
Faulty status of the connection between diesel generator DC systems at Loviisa 2	•	•	0

Two events occurred at the Loviisa plant resulting in non-compliance with the Technical Specifications. The safety significance of both events was low but, as a result, actions to improve safety were initiated. In addition, the utility applied for the approval of seven deviations from the Technical Specifications. Five of the applications concerned prolonged repairs of component malfunctions. In the future, attention must be paid to this issue, as all faults should be repaired within the time limits set in the Technical Specifications. STUK approved the applications after analysis (Appendix 1, indicator A.I.2).

The Technical Specifications of the Loviisa power plant are currently up-to-date, and the document is sufficiently easy and clear to use. The number of deviations from and non-conformances with the Technical Specifications is low, indicating that the plant has been operated in a manner that ensures good nuclear safety.

Operation and operational events

One resident inspector is employed at the Loviisa power plant to oversee the operation of both plant units on a daily basis. In addition, operation is controlled according to a systematic programme drafted for this purpose. As a new feature, STUK's periodic inspection programme includes inspections of operating activities performed on a quarterly basis since the beginning of 2007. In these inspections, utility representatives present significant issues related to nuclear and radiation safety and operation and maintenance activities, as well as the situation of corrective action initiated due to events reported to STUK. The inspections include rounds in various areas of the plant. Significant issues related to operation were not raised in the inspections. In connection with the inspections, STUK required improvements to housekeeping at the plant and the storage of goods and the marking of storage areas at the plant.

The impact of inoperabilities resulting from component malfunctions, preventive maintenance and other events on the annual accident risk was very low, rating about 0.9% at Loviisa 1 and about 2% at Loviisa 2. A few individual component malfunctions and the preventive maintenance of the subsystems of the auxiliary feed water system were most significant in terms of risk.

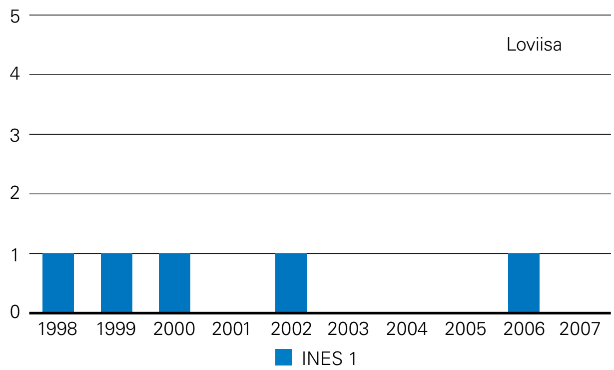


Figure 6. INES classified events at the Loviisa plant (INES Level 1 or higher).

Operation and operational events

The Loviisa plant units operated reliably in 2007. The load factor of Loviisa 1 was 94.6% and that of Loviisa 2 was 96.1%.

The duration of the annual maintenance outage was 20 days at Loviisa 1 and 15 days at Loviisa 2. In addition, brief reductions in output capacity occurred in both plant units due to technical failures. The most significant of these were a turbine shutdown at Loviisa 1 for repair of a hydrogen leak in a generator, and damage to and repair of a support bearing in a main service water pump. Production losses in nominal output caused by component malfunctions were low as a whole, 0.34% at Loviisa 1 and 0.23% at Loviisa 2. Production losses from component malfunctions over a longer time period are depicted by the indicators in Appendix 1 (indicator A.I.1g).

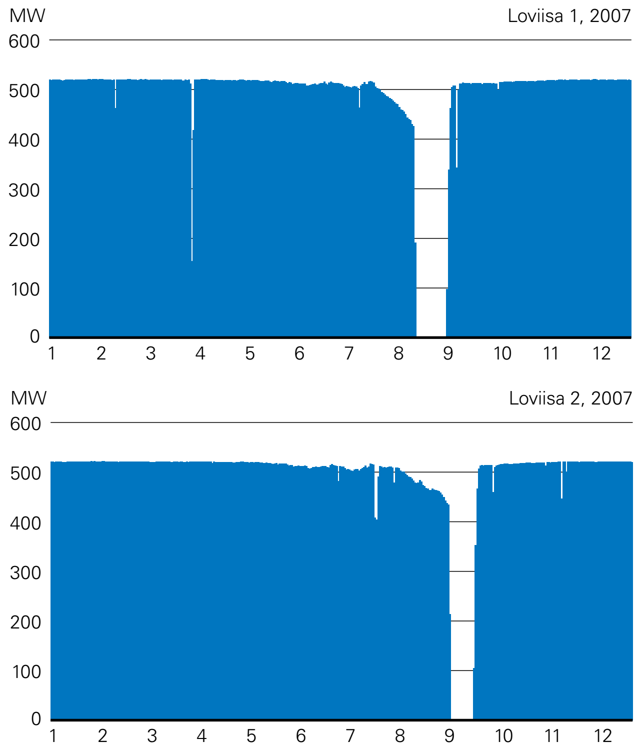


Figure 7. Daily average gross power of the Loviisa plant in 2007.

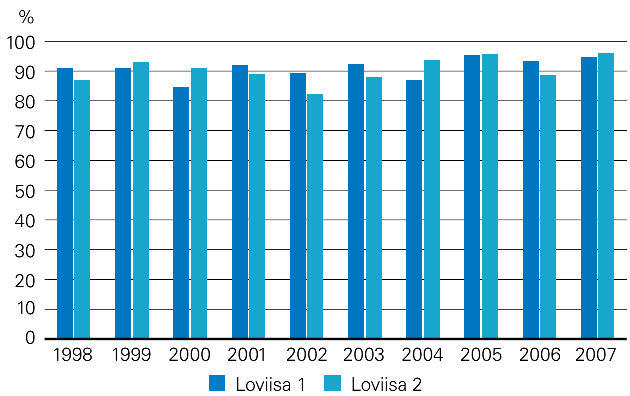


Figure 8. Load factors of the Loviisa plant units.

Annual maintenance outages

Based on STUK's oversight, it could be determined that the annual maintenance at the Loviisa power plant was planned well and implemented safely.

96 days during normal working hours were spent on overseeing annual maintenance outages. In addition, one resident inspector worked regularly on-site. The oversight of annual maintenance outages also included a total of 89 inspection days outside working hours.

Annual maintenance at Loviisa 1

The short refuelling outage at Loviisa 1 was carried out between 18 August and 7 September 2007, taking two days longer than planned. Reasons for the longer duration included servicing four main coolant pumps instead of two, and the repair of an isolation valve of the special sewerage of the containment at the end of the outage.

Two malfunctions in power supply occurred during the Loviisa 1 outage: malfunction of an over-current relay on 22 August 2007 (resulting in non-compliance with the Technical Specifications, indicator A.I.1g) and a malfunction in the national grid on 24 August 2007. The events did not compromise plant safety.

In addition to refuelling, the annual maintenance included normal servicing operations and inspections, and servicing of four reactor coolant pumps. Maintenance of the secondary circuit included servicing of service water pumps. Turbine and generator inspections were carried out, and preparations were made for the replacement of a generator stator in 2008. As a modification operation, a rewound reactor coolant pump motor was installed during the annual maintenance. As a safety-improving modification, the blow-down system pipe for two steam generators was duplicated. On a steam generator, one end of a defective heat transfer tube was plugged, which could not be performed in 2006.

Annual maintenance at Loviisa 2

The refuelling outage at Loviisa 2 began on 8 September 2007 and ended on 23 September 2007, about four hours ahead of schedule. The outage was the shortest in the Loviisa plant's history, taking 14 days and 21 hours.

Three new cracked buses were detected in the 6kV switchgear, which were repaired. This represents an ageing phenomenon only evident at Loviisa 2, due to the structure of the buses, which will be monitored in the future as well.

In addition to refuelling, the annual maintenance included servicing operations and inspections, inspections of reactor pressure vessel head sealing grooves and servicing of two reactor coolant pumps. During the outage, one service water pump was serviced and one pump was replaced. 6kV switchgear buses were inspected to detect potential new cracks. The annual outage also included turbine and generator inspections. As a safety-improving modification, the blow-down system pipe for one steam generator was duplicated.

Plant maintenance and ageing management

In 2007, STUK evaluated the report on ageing management at the Loviisa plant submitted by Fortum Power and Heat Oy. The documents describe the principles and implementation of lifetime management, and the condition and lifetime extension bases of components, structures and systems. STUK found that the ageing management programme in the proposed form is deficient compared with the requirements contained in Guides YVL 5.2 and YVL 5.5. The utility has been requested to present a plan for remedying the deficiencies.

STUK also inspected the maintenance of qualification for systems, components and structures at the Loviisa power plant. STUK required that the maintenance of qualification is developed to make it more systematic, taking into account the traceability of qualification, any changes taking place during plant operation, updates to safety analyses and amendments to the qualification requirements. The utility submitted the programme concerning the maintenance and follow-up of the Loviisa power plant towards the end of 2007.

STUK assessed the ageing management process of the power plant and verified the information contained in the submitted documents through annual periodic inspections on-site. STUK has found that the availability of qualified spare parts for some I&C components is poor. Fortum Power and Heat Oy has started the procurement of spare parts meeting the requirements for neutron flux detectors, for example, which are used during reactor start-up and shutdown.

STUK reviewed the plans for modifications in the electrical and I&C systems and supervised some of the commissioning inspections of modifications. Significant repair and maintenance operations concerning electrical components included the replacement of reactor coolant pump and sea water pump motors. During the annual maintenances, STUK oversaw the periodic inspections and testing of electrical and I&C systems and components. The electrical engineering and I&C technology section of the Loviisa power plant's inspection organisation carried out more than 40 commissioning inspections after the modifications of safety-classified systems.

No significant observations concerning the ageing management of mechanical components were made during annual maintenance at the Loviisa plant units. In-service inspections of the reactor pressure vessel and the main coolant piping according to Guide YVL 3.8 were carried out as a duty of the licensee at both plant units. STUK's oversight included the approval of the inspection programmes prior to the inspections, oversight of the inspections and review of the results on-site. The final result reports will be submitted to STUK for approval after the annual maintenance. STUK reviewed on-site the results of the condition monitoring inspections of the secondary circuit piping made by the licensee.

In inspections performed during annual maintenances in 2004, the utility detected water between the penetration nozzle pipe and its inner corrosion protection pipe in two penetrations for control rod drive mechanisms in the reactor pressure vessel heads at both of the Loviisa plant units. At the upper end of the seal weld of the protection sleeve water seeps in through a crack, which expands when the structure cools down during reactor shutdown. When the structure warms up to operating temperature, the water remains inside and may cause bulging of the sleeve. The inspections were carried out on the basis of operational experience feedback from VVER plants of the same type. After detection, the penetration nozzles have been inspected annually using TV cameras, and no bulging caused by water or other visible changes have been observed. At Loviisa 2, the assemblies were repaired by replacing the corrosion protection pipes during the 2006 outage. A corresponding repair will be carried out at Loviisa 1 during the 2008 annual maintenance outage.

At Loviisa 1, the fastening bolts of the reactor core support basket were inspected at the locations of replaced fuel elements and control rods. The bolts were verified to be securely in place. A dye penetrant test was carried out on the sealing grooves of the flange surface of the reactor pressure vessel. No defects were found in the inner sealing grooves repaired in 2006. The cracks in the outer sealing grooves detected the same year and not repaired had not increased. Furthermore, a few new cracks were detected in the outer sealing grooves, which were not repaired and will be monitored. On one steam generator, one end of one heat transfer tube was plugged. This had not been performed in 2006, as the mouth of the tube had to be ground before plugging and the workers were not

Pressure equipment manufacturers and inspection and testing organisations

During the operating year, one new pressure equipment manufacturer was authorised for the Loviisa power plant. Three testing organisation authorisations according to Guide YVL 1.3 were granted. In addition, three testing organisations were authorised to conduct in-service inspections according to Guide YVL 3.8. The authorisation of the inspection organisation of the Loviisa nuclear power plant was renewed for five years. In addition, a separate unit of the inspection organisation was authorised to carry out inspections in the electrical and I&C area. The licence of one testing organisation was withdrawn due to lack of accreditation.

prepared for it. In addition, condensate chambers were installed on two steam generators to enable stabilising water level measurement. STUK approved the related structural designs and trial run programmes before the annual maintenance outages. In addition, during the annual maintenance, pressuriser main safety valves and three reactor coolant pumps were serviced and inspected, and the control rod drive mechanisms were serviced. Steam generator main safety valves underwent annual testing before the outage.

The sealing grooves at flange level in the reactor pressure vessel were also inspected at Loviisa 2. The old cracks had not increased, but a new spot-type defect indication was detected in the surface area between the second and third grooves. The new defect was not repaired as, according to the utility's action plan, the sealing surface will be repaired at one plant unit in 2008. In addition, the pressuriser safety valve control valves, steam generator main safety valves, two reactor coolant pumps and control rod drive mechanisms were serviced and inspected as at Loviisa 1.

There were two periodic inspections of pressure equipment in STUK's inspection area at each plant unit. STUK supervised at both plant units inspections of safety Class 3 and 4, as well as Class EYT (non-nuclear) pressure equipment performed by inspection organisations.

During the year, STUK made a total of 132 construction inspections and inspections of on-site modifications and repairs, as well as 10 commissioning inspections.

Radiation safety

Occupational radiation safety

On the basis of documents submitted by Fortum Power and Heat Oy, STUK approved the use of the dosimetry system of the Loviisa nuclear power plant until 2011. Revisions of the dosimetry instructions and procedures will be submitted to STUK for approval in 2008. The dosimeters used for measuring the occupational radiation doses underwent an annual test with acceptable results. The test comprises irradiating a sample of dosimeters at STUK's measurement standard laboratory and determination of the doses at the power plant.

STUK carried out a radiation protection inspection according to the periodic inspection programme at the Loviisa plant, covering the resources, expertise and operation of the radiation protection organisation. STUK required the Loviisa plant to develop its operations further and, among other things, intensify the radiation protection training of work planners and organise preliminary practice for demanding maintenance operations.

STUK carried out outage radiation protection inspections during the annual maintenances at the Loviisa plant units. The inspections showed that the plant has developed the radiation signs and labelling of work areas, for example. STUK will continue inspections to assess the use of radiation work permits at the plant, contamination monitoring during annual maintenance and guidance concerning work areas. The Loviisa plant's radiation protection guidelines are being developed further with regard to surface contamination measurements, for example. The plant is also assessing whether changing the order of annual maintenances in the future would be useful in terms of implementing more efficient radiation protection.

Radiation doses

The collective occupational radiation dose was 0.41 manSv at Loviisa 1 and 0.32 manSv at Loviisa 1. According to STUK guidelines, the threshold for one plant unit's collective dose averaged over two successive years is 2.5 manSv per one gigawatt of net electrical power. This means a collective dose value of 1.22 manSv per each Loviisa plant unit. This value was not exceeded at either plant unit. The collective dose of the Loviisa plant units was a record low in operating history. The collective occupational dose at the Loviisa units in 2007 was also low compared with the average level of PWRs in the OECD countries.

The annual collective radiation dose mainly accumulates in operations performed during annual maintenance outages. The collective radiation dose due to operations during the outage at Loviisa 1 was 0.37 manSv, while the highest individual radiation dose incurred during the outage amounted to 6.27 mSv. The collective radiation dose due to operations during the annual maintenance outage at Loviisa 2 was 0.28 manSv, while the highest individual radiation dose incurred during the outage amounted to 5.34 mSv. The highest radiation dose incurred during the outages at both plant units was 9.82 mSv.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2007 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

The majority of the radioactive substances generated during nuclear reactor operation originate in nuclear fuel and the reactor cooling system, as well as the related purification and waste systems. The liquid and atmospheric releases from the plant are purified and delayed so that their radiation impact on the environment is very low compared with the impact of radioactive substances normally existing in nature. The releases are carefully measured to ensure that they remain clearly below the prescribed limits. The calculated radiation dose of the most exposed individual in the vicinity of the plant has been less than one per cent of the set limit of 0.1 millisievert during the past few years.

STUK required the Loviisa plant to assess not only the development of the weather mast system on-site, but also that of off-site real-time additional measurements and the related predictive models in 2007–2009 with regard to the spreading of any atmospheric releases.

The current programme for environmental radiation monitoring in the surroundings of the Loviisa power plant has been approved for 2003–2007. Experts at the utility and the independent laboratory carrying out measurements presented their experiences and development needs for the new period extending until 2012. The programme will be submitted in its final form to STUK for approval at the beginning of 2008.

Table 3. Radioactive nuclides originating from the Loviisa plant detected in environmental samples in 2007.

Sample	Observed nuclides (number of samples)
Air	Co-60 (2)
Aquatic plants	Co-60 (6), Ag-110m (5), Mn-54 (1), Co-58 (3), Sb-124 (3)
Sediment	Co-60 (7), Ag-110m (1)
Seawater	H-3 (7)

STUK reviewed the Loviisa plant's quarterly and annual reports on radioactive releases and environmental monitoring.

Releases from the Loviisa nuclear power plant into the environment in 2007 were significantly below the prescribed limits. Releases of radioactive noble gases into the air were approximately 5.5 TBq, which is approximately 0.03% of the authorised limit. The releases of radioactive noble gases were dominated by argon-41, i.e. the activation product of argon-40, originating in the air space between the reactor pressure vessel and the main concrete shield. The releases of radioactive iodine isotopes into the air were about 0.7 MBq, i.e. approximately 0.0004% of the authorised limit. Aerosol releases were approximately 0.1 GBq, tritium releases approximately 0.2 TBq and carbon-14 releases approximately 0.2 TBq.

The tritium content of liquid effluents released into the sea, i.e. 16 TBq, is approximately 11% of the release limit. The total activity of other nuclides released into the sea was about 0.4 GBq, i.e. about 0.04% of the release limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.05 microSv, i.e. less than 0.1% of the set limit (Appendix 1, indicator A.I.5). The radiation emitted by natural radioactive elements in the soil of the environment of the plant causes a person outdoors to incur an equivalent dose in about 15 minutes.

A total of 317 samples were collected and analysed from the environment of the Loviisa power plant in 2007. A wide-ranging and comprehensive monitoring programme approved by STUK is being implemented in the surroundings of the nuclear power plant. The programme is extensive, and more than 300 samples are taken from air and terrestrial and marine environment surrounding the plant site each year. External background radiation and the radioactivity of people in the vicin-

OSART review

OSART is a service provided by the Internal Atomic Energy Agency (IAEA) to its member countries, where an international Operational Safety Review Team conducts an extensive assessment of the operational safety of a nuclear power plant. The review team assesses the safety level of the power plant and identifies areas for improvement, to assist the plant in continuously improving its operational safety. The review team also identifies good practices and operating models employed at the plant that may benefit other power plants. The review visits are made at the request of the host country.

An OSART review covers eight areas:

- *management, organisation and administration*
- *training and qualification*
- *operations*
- *maintenance*
- *technical support*
- *radiation protection*
- *operational experience feedback*
- *chemistry*
- *emergency planning and preparedness.*

ity are also measured regularly. Extremely small amounts of radioactive substances originating in the nuclear power plant have been observed in some of the analysed samples. The amounts are so small that they are insignificant in terms of radiation exposure.

Emergency preparedness

Besides the periodic inspections of other operations, STUK controls the preparedness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Loviisa power plant in 2007.

Emergency preparedness at the Loviisa power plant meets the key regulatory requirements, which was determined in a periodic inspection held in September 2007. The inspection focused on the reorganisation of the emergency response organisation's premises, testing of the connections used for plant data transfer during an emergency situation and the securing of connections, and the development of the power plant's internal alerting procedures.

The Loviisa power plant and the Eastern Uusimaa Fire and Rescue Services maintain in co-operation their preparedness for an accident at the Loviisa nuclear power plant, e.g. by harmonising the support material used in emergency situations, such as map templates and measurement patrol routes, and by improving the transmission of measurement data so that it is collected directly in a common database.

The emergency exercise at the Loviisa power plant was held on 23 November 2007.

Oversight of organisational operation

Safety management

The emphasis in terms of safety management was on the comprehensive assessment of the safety and operation of the plant (see section "Operating licence"). In addition, the IAEA carried out an OSART inspection of the Loviisa power plant in March 2007.

The safety management inspection at the Loviisa power plant focused on the substitute arrangements for the responsible manager, the management of personnel resources and facilities, the management of safety and quality issues and the assessment and improvement of operations. STUK required the Loviisa power plant to clarify the substitute arrangements for the responsible manager and improve the monitoring of deadlines set by the authorities. STUK also emphasised that the systematic character, efficiency and effectiveness of operational planning must be improved further, and that particular attention must be paid to the implementation of self-assessment and management reviews.

The responsible manager at the Loviisa power plant changed at the beginning of 2008. STUK approved the new responsible manager and his substitute on the basis of the application and assessment discussions.

The management of the Loviisa power plant must pay attention to the operational planning and monitoring of the attainment of objectives, working rooms and personnel's working conditions, as well as the monitoring of the implementation and schedules of modification projects. In 2008, STUK will carry out targeted inspections of operational planning, setting of objectives and the allocation of resources at the Loviisa power plant.

Quality management system

STUK carried out an inspection where it assessed the functionality and scope of the Loviisa power plant's quality assurance system and the quality management of procurement activities.

The Loviisa power plant has a functional and comprehensively regulated quality assurance system. Special attention has been paid to the systematic implementation of internal follow-up inspections, and a number of comprehensive inspections have been targeted at areas important to nuclear safety. The Loviisa power plant I&C system upgrade project has had problems in terms of not only its schedule but also with supplier inspections related to procurement and the procedures applied at the power plant to monitor quality assurance in delivery projects.

In 2008, STUK will follow improvements in the monitoring of the procurement procedure and suppliers at the Loviisa power plant.

Personnel qualifications and training

STUK carried out an inspection at the Loviisa power plant focusing on the development of expertise management, training activities and the organising of training activities. The inspection also covered the progress of the instructions and training subproject of the Loviisa I&C system upgrade project and the qualification requirements for external subcontractors and work supervision and their training for annual maintenances in 2007. The training activities and their organisation have been implemented appropriately at the Loviisa power plant. STUK required for particular attention to be paid to the orientation of new personnel and the implementation of familiarisation programmes and that the sufficiency of training facilities should be assessed. In addition, a sufficient number of personnel must be allocated for the instruction and training subproject of the I&C system upgrade project and the plans must be updated to reflect the changes in the project.

Human resource planning at the Loviisa power plant is based on a ten-year plan, which is subject to annual management review and updating. Dozens of new personnel have been recruited at the plant during the year. The sufficiency of personnel resources has been found to be critical in a number of tasks, such as quality control, quality assurance, risk assessment and radiation protection.

Operational experience feedback

Fortum has established a special Operational Experience Feedback Group (KKR) for the collection, screening, analysis and entry into processing of operational experience data from other nuclear power plants. Group members have expertise in various areas of technology. Besides the Loviisa nuclear power plant, the group also serves Fortum's other functions. The group's key sources of information include the World Association of Nuclear Operators (WANO) as well as the IAEA and the OECD/NEA through the Incident Reporting System (IRS) maintained by them. The operational experience data processing group reviews the reports received and investigates whether any of the events requires measures to be taken at the plant or in its procedures and instructions. The group provides recommendations for further processing and decisions to be made on possible further action. The Loviisa power plant receives operational experience data from VVER plants in the framework of co-operation in various fields of technology.

Reports were completed on all of the significant own events entered into processing at the Loviisa power plant in 2007. At its meetings in 2007, KKR handled a total of 48 event and investigation reports concerning other power plants, of 800 reports pre-screened from various sources. KKR issued a recommendation on the radiation protection assessment of the industrial radiography imaging performed at the plant.

The utility recruited six new personnel for operator training during the year. STUK authorised seven new operator trainees with two-year licences on the basis of written examinations. Six people took the oral exam and were authorised as new operators. The operator licences of 17 people were renewed, one examination result was considered failed, and one operator licence expired during the year.

The occupational safety and health system (OHSAS 18001) is being developed at the plant. This was visible in 2007 in that attention was paid to the radiation protection and occupational safety of personnel and contractors, and the orderliness of the working environment, for example.

Operational experience feedback

Few events at the Loviisa power plant have called for a special report. In 2007, two non-conformances with the Technical Specifications concerning electrical systems were reported. The safety significance of both events was low. In the case of the first event, the utility also conducted a separate root cause analysis, based on which the procedures concerning the co-ordination and implementation of modifications were made more specific, the phasing of work in the work order system was specified further and the inspection instructions for electrical installations were supplemented. In the second case, the causes were obvious, and corrective action comprised clarifying the technical causes of the event and eliminating their impacts.

A disturbance report must be drawn up on any significant operational disturbances. The number of such transients at the Loviisa power plant has remained moderate and, in 2007, disturbance reports were drawn up on a total of eight events. No reactor scrams took place at the Loviisa plant units in 2007.

Internal processing at the plant and reporting is also required for low-level events or near-misses not subject to a special or disturbance report. Reports on such events are submitted to STUK for information if the event is or may be relevant to nuclear or radiation safety or STUK's communication activities. In 2007, the Loviisa power plant submitted eight such event reports to STUK.

STUK reviewed the event reports submitted by the licensee and the annual summary of operational experience feedback activities. In addition, operational experience feedback activities were the subject of two inspections within the periodic inspection programme. In the inspection of operational experience feedback activities in 2007, it was remarked that only a few root cause analyses have been carried out at the Loviisa power plant in connection with the most significant events over the past few years, which is due to the extremely heavy method. The power plant has already started to develop the method in a lighter direction. In addition, attention was paid to the resources of international operational experience feedback activities, which were improved towards the end of 2007.

It was found in the inspection concerning the utilisation of international operational experience feedback that the utility has established procedures for these activities and that the Loviisa power plant actively aims to improve its efficiency. A more comprehensive screening of IRS reports was identified as a target for development. The plant assumed that noteworthy events are included in the reports of the World Association of Nuclear Operators (WANO).

The Loviisa power plant has systematic procedures and guidance for investigating and assessing events of their own, as well as initiating corrective action and monitoring its implementation. No significant recurring events are evident in the plant's operational events, and their number and severity are decreasing. The power plant has identified and taken action on its own initiative to improve resources, know-how and procedures. According to STUK's assessment, root cause analysis and the recording of human factors, among other things, need to be developed.

Spent nuclear fuel and low- and intermediate level waste

STUK oversees the nuclear waste management of nuclear power plants through document reviews and the periodic inspection programme.

STUK carried out the inspections according to the periodic inspection programme at the Loviisa power plant. The inspection of low- and intermediate-level waste management focused on the situation of the construction and reorganisation project for the storage, waste and repair shop facilities, the arrangements at the liquid waste solidification facility, waste accounting, organisation and instructions. The inspection concerning the final disposal facility for low- and intermediate-level waste focused on the maintenance procedures for the concrete and rock structures of the final disposal facility. No significant deficiencies were detected in the inspections.

In 2007, maintenance waste below the activity limits taken to Kymenlaakson Jäte Oy's landfill, as well as scrap metal, were cleared from control at the power plant with STUK's approval.

No events significant to plant or environmental safety were evident in the treatment, storage or the final disposal of low- and intermediate-level waste ("operating waste") at the Loviisa power plant. The volume and activity of operating waste in relation to generated electrical power remained relatively low compared with most other countries. The contributing factors include the high quality standards for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination, component and process modifications, as well as waste monitoring and sorting, which enable clearing some of the waste from control. The power plant employs efficient procedures for reducing the volume of waste subject to final disposal.

The waste processing facilities at the Loviisa power plant are cramped and impractical. The construction and reorganisation project for storage, waste and repair shop facilities mentioned above will improve the facilities and equipment for waste processing. The maintenance of low- and intermediate-level waste will be improved by introducing centralised facilities for waste processing, activity determination and interim storage. The construction work under the project started in 2007 and is scheduled to be completed at the end of 2009.

STUK reviewed plans relating to the extension of the final disposal facility for low- and intermediate-level waste. A reception facility for solidified waste will be completed in the extension.

Waste volumes

The volume of low- and intermediate-level waste was 3,060 m^3 at the end of 2007. The volume increase from 2006 is 70 m^3. Approximately 48% of the waste has been disposed of.

The volume of spent nuclear fuel stored on-site at the Loviisa power plant at the end of 2007 was 3,565 assemblies (429 tU) and the increase 204 assemblies (26 tU). The storage capacity at the Loviisa power plant will be increased by employing more dense racks. The first two dense racks were installed in February 2007.

4.2 Olkiluoto nuclear power plant units 1 and 2

4.2.1 Overall safety assessment of Olkiluoto NPP units 1 and 2

The safety of the Olkiluoto nuclear power plant has remained good

The condition of the multiple barriers containing releases of radioactive substances has remained good. Teollisuuden Voima Oy aims to prevent fuel leaks by more effectively preventing loose parts from entering the reactor, but a small fuel leak caused by a loose part was detected at Olkiluoto 2 during the 2006–2007 operating cycle. Inspections of the reactor pressure vessel and piping revealed no deterioration of the materials. The results of annual tests show that the leak-tightness of the containment and isolation valves has remained good.

Three reactor scrams occured due to disturbances at Olkiluoto 2 in 2007. The number is considerably higher than average over the past few years. However, situations compromising nuclear and radiation safety did not occur. Plant operation has been systematic and in compliance with the Technical Specifications and guidelines, except for in two situations. The condition of components and systems designed to prevent accidents and mitigate their impact has remained good. No indications of condition deterioration were detected in periodic tests and preventive maintenance. The number of safety system component failures has been low. A failure was detected in the reactor scram system at Olkiluoto 2 in connection with an operational transient.

The Olkiluoto plant employs an ageing management programme aimed at guiding the maintenance and modification operations at the entire plant so that the plant can be operated safely throughout its lifetime. No effects pertaining to ageing that endanger plant safety were evident in inspections during 2007. No safety-endangering factors are evident in maintenance-related safety performance indicators, either. No modifications important to safety were carried out at the Olkiluoto nuclear power plant. According to the risk analysis, the safety of the Olkiluoto power plant has improved slightly thanks to the small improvements made. Modifications were implemented at the turbine plant to improve plant operability.

Plant operation did not cause a radiation hazard to the workers, the population or environment. Occupational radiation doses and radioactive releases into the environment were low and clearly below the prescribed limits. The installation of new steam dryers in 2006 and 2007 has reduced radiation at the turbine plant to the level of 1998. This also reduces the occupational radiation doses of turbine plant workers. Emergency preparedeness at the Olkiluoto power plant is in compliance with regulatory requirements. The functionality of the emergency response was tested during an emergency exercise organised at the end of November.

Teollisuuden Voima Oy has set its safety objectives high. Several actions to enhance the safety culture are in progress at the plant. The self-assessment of the safety culture was repeated at the utility in 2007, and the results showed improvement compared with the assessment in 2004. Several events occurred at the power plant in 2007 where deficiencies in quality and information management could be identified behind the events. The utility identified deficiencies related to guidelines, among other things, through its event analysis process. For example, errors have been detected in the reactor monitoring system software, the wrong type of fuses have been installed and deficiencies have been detected in guidelines and operation orders. More attention must be paid to the correctness of the plant's data systems and documents.

Teollisuuden Voima Oy is investing in personnel training. In addition to offering training, the utility must ensure that personnel have sufficient time for training and development. The utility has recruited more personnel and started human resource planning in view of the needs of Olkiluoto 3. Attention must still be paid to the sufficiency of personnel resources, particularly in the fields of reactor physics and electrical and I&C systems maintenance.

4.2.2 Oversight and observations

Licence statements

The operating licence of Olkiluoto 1 and 2 plant units is valid until the end of 2018. No licence statements were prepared concerning the plant units in 2007. Teollisuuden Voima Oy must draw up a periodical safety review of the condition of the plant units and its development by the end of 2008. In 2007, STUK initiated discussions with Teollisuuden Voima Oy on the content of the periodical safety review and prepared a project plan for the review of the document.

Review of safety analyses

Deterministic safety analyses

No plant modifications were implemented at the Olkiluoto plant units in 2007 that would have called for revising the transient and accident analyses. In connection with annual refuelling, the licensee submits certain key analyses related to the safety of the plant units to STUK for approval. The purpose of these analyses is to prove that reactor properties do not change on refuelling so that the safety margins would be significantly reduced. The analyses submitted in connection with refuelling in 2007 ascertained this.

No other deterministic safety analyses concerning the Olkiluoto plant units were submitted to STUK for approval in 2007.

Probabilistic risk analyses

Teollisuuden Voima Oy implemented an improvement programme concerning the reactor building cooling risk between 2005 and 2007. The programme assessed and reduced the risks related to the loss of heating in instrumentation rooms at Olkiluoto 1 and 2 during severely cold weather. According to preliminary assessments, the freezing of impulse lines for reactor level measurement located in the reactor building had substantial risk significance. Plant modifications were implemented to reduce these risks. The utility surveyed the instrumentation rooms where safety-significant components sensitive to the loss of heating are located. Other particularly risk-significant areas were not identified. During the 2007 annual maintenance, new temperature alarms were installed in about 20 rooms at each plant unit. An alarm signal will be given to the control room if the temperature of these rooms drops too low. More specific risk analyses show that the risk-significance of the cooling of instrumentation rooms has been reduced to a very low level.

In 2007, STUK reviewed the updated risk analysis for annual maintenance outages at Olkiluoto 1 and 2 drawn up by Teollisuuden Voima Oy. Outages are characterised by reactor servicing operations, where errors may cause hazardous situations. For example, errors made in connection with the servicing of reactor coolant pumps fastened to the bottom of the reactor pressure vessel could result in a reactor bottom leak that is difficult to control. The utility has previously implemented a number of improvements in the procedures applied during outages. According to the latest update to the outage risk analysis, the outage-related risk has decreased further due to the new modifications to the reactor coolant pump servicing procedures. The current outage risk is only about 1.3% of the plant's total risk.

Oversight of plant modifications

A rather small number of large-scale modifications were implemented at the Olkiluoto nuclear power plant in 2007. The number of modifications dur-

Table 4. Events at the Olkiluoto plant units subject to special reports by the utility. The table shows events due to which the plant unit was in non-compliance with the Technical Specifications. All events subject to reporting are discussed in Appendix 1 (indicator A.II.1). Appendix 3 describes events subject to special reports in more detail.

Event	Non-compliances with the Technical Specifications	Special report	INES rating
Violation of dryout limits at Olkiluoto 1 as a result of programming error	•	•	0
Testing of main steam relief valves in the wrong operational state	•	•	0
Reactor trip at Olkiluoto 2		•	1
Unqualified fuses in the electrical systems of Olkiluoto 1 and Olkiluoto 2		•	1
Wrong fuses in the shut-down secondary cooling system of Olkiluoto 2			0
Unlocked containment isolation valves at Olkiluoto 1 and Olkiluoto 2 non-compliant with the Technical Specifications	•	•	0

ing the maintenance outage at Olkiluoto 2 was about 130, of which during the refuelling outage at Olkiluoto 1 there were about 40. The largest modifications, such as the replacement of the extraction lines of the low-pressure turbine and the piping and valve replacements for the turbine drain lines were implemented during the maintenance outage at Olkiluoto 2.

A project to upgrade the fixed radiation measurement systems has been started at both of the Olkiluoto plant units. The first upgraded exhaust gas system radiation measurement devices were commissioned at Olkiluoto 2 after the 2007 annual maintenance. The installed devices have functioned perfectly. Most of the project will be implemented in 2008 and 2009.

Oversight of plant operability

Compliance with the Technical Specifications

Compliance with the Technical Specifications at the Olkiluoto power plant was controlled by witnessing operations on-site. Oversight focused on the testing

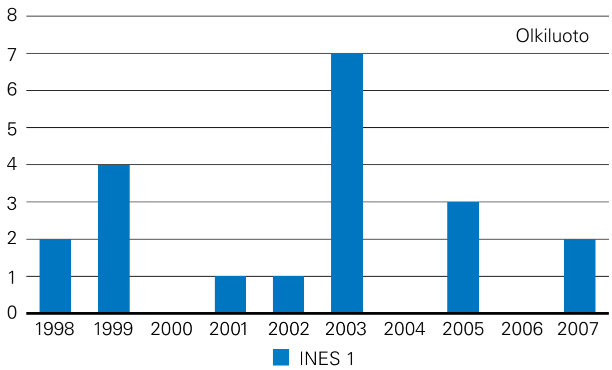


Figure 9. INES classified events at the Olkiluoto plant (INES Level 1 or higher).

Operation and operational events

The operation of Olkiluoto 1 was nearly free of disturbances. On the other hand, a number of disturbances occurred at Olkiluoto 2, resulting in higher production losses than in previous years.

The load factor of Olkiluoto 1 was 97.5% and that of Olkiluoto 2 was 93.7%. The annual maintenance outages caused the most significant reductions in the load factor: the outage at Olkiluoto 1 lasted 8.5 days and that of Olkiluoto 2 lasted 17 days. Losses in the gross energy output due to component malfunctions were 0.04% at Olkiluoto 1 and 1.3% at Olkiluoto 2. Production losses from component malfunctions over a longer time period are depicted by the indicators in Appendix 1 (indicator A.I.1g).

No significant breaks in power generation or power losses due to component failures occurred at Olkiluoto 1. A mechanical seal of a feed water pump sustained damage during power operation of the plant unit, and power was reduced for the duration of its replacement on 3 April 2007. During a periodic test at Olkiluoto 1 on 5 July 2007, a pressure gauge exploded and the discharging hydrogen caught fire. The fire was extinguished immediately by the fire brigade, and no serious injuries were sustained.

Seven events related to component malfunctions and disturbances occurred at Olkiluoto 2, causing production breaks or power losses. Three reactor scrams occurred at the plant unit due to disturbances: on 15 May 2007, 4 September 2007 and 29 December 2007. Power was reduced once to investigate a valve malfunction in the blow-down system and twice to investigate and even out vibrations in the low-pressure turbines. Start-up of the plant unit after annual maintenance had to be interrupted when oil remaining in the insulation of a high-pressure turbine, due to an oil leak, caught fire. The fire was extinguished, the oil was removed, and the damage caused by the fire was repaired.

and repair of components subject to the Technical Specifications. After the completion of the annual maintenance outages, the plant units' state in compliance with the Technical Specifications was ascertained prior to start-up.

Two unintentional situations of non-compliance with the Technical Specifications occurred at the Olkiluoto plant in 2007. In addition, the utility applied for the approval of five deviations from the Technical Specifications. STUK approved all of the applications. Four of the temporary exemptions concerned deviations from the Technical Specifications necessary for plant modifications or modernisations, and one was related to the test in progress at the repository of low- and intermediate-level waste (Appendix 1, indicator A.I.2).

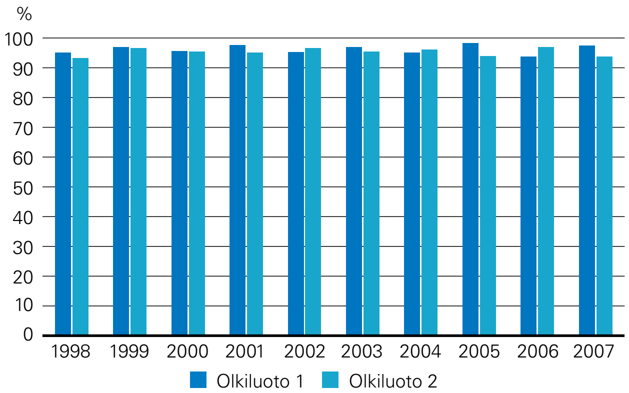


Figure 10. Load factors of the Olkiluoto plant units.

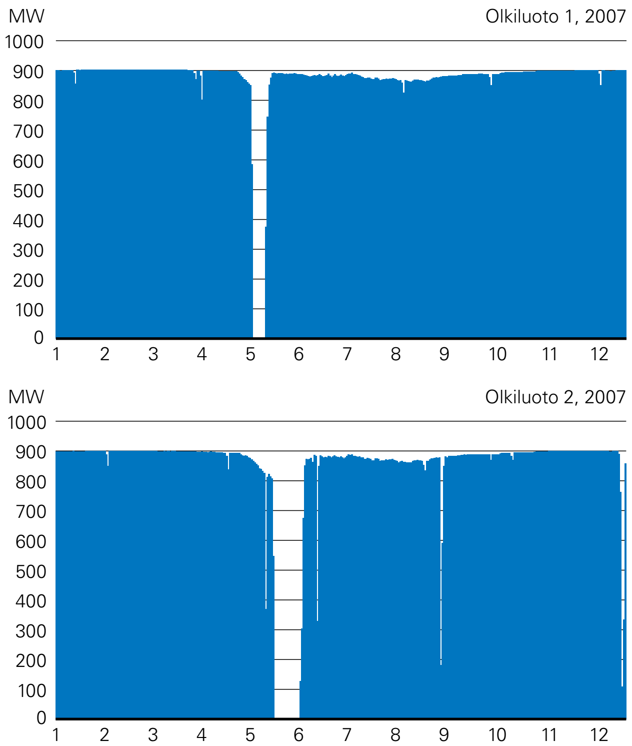


Figure 11. Daily average gross power oh the Olkiluoto plant units in 2007.

Teollisuuden Voima Oy is carrying out an overall review of its Technical Specifications. The part concerning conditions and restrictions and their justifications were assessed in 2007. The assessment and development of the Technical Specifications is part of the periodical safety review.

The utility submitted 12 amendment proposals to STUK for approval, concerning issues such as component inspections, testing and calibration. Amendments were also implemented due to component upgrades. STUK approved the amendments as such, or required that additional information, such as updated operating instructions should be submitted in arrears. Three amendment proposals were returned for new preparations, either in their entirety or partially. One amendment was not approved as the implementation of the modification was postponed.

Operation and operational events

Two resident inspectors are employed at the Olkiluoto power plant to oversee the operation of the operating plant units on a daily basis. In addition, operation is controlled according to a systematic inspection programme drafted for this purpose. As a new feature, STUK's periodic inspection programme includes the inspections of operations performed on a quarterly basis since the beginning of 2007. In these inspections, utility representatives present significant issues related to nuclear and radiation safety and operation and maintenance activities. The requirements related to the scram system valves, in particular, were prominent in the inspection records. The utility detected sealing problems in the valves and one malfunction. STUK required a further report on the nitrogen leaks from the valves and requested the utility to assess the schedule and criteria for corrective action to be taken during the 2008 annual maintenance.

The impact of inoperabilities due to component malfunctions, preventive maintenance and other events on the annual accident risk was about 6% at each plant unit. This was due to the long duration of the preventive maintenance packages for the diesel generators and latent component failures in the safety systems. No special action by STUK was required due to the target level being exceeded.

Annual maintenance at Olkiluoto 1

The annual maintenance at Olkiluoto 1 comprised a refuelling outage that took place between 6 and 15 May 2007. The outage lasted 8.5 days.

Eight control rod drive mechanisms were inspected to investigate the problems that had occurred since the 2006 annual maintenance, concerning control rod drive mechanism trips from torque protection. The observations supported the assumption that impurities carried by scram system water on top of the drive nut triggered the torque protection (see Annual report 2006).

Annual maintenance at Olkiluoto 2

The maintenance outage at Olkiluoto 2 took place between 20 May and 6 June 2007. The outage also included modification operations. The outage that took almost 17 days was more than 1.5 days longer than planned. The delay was caused by an oil leak in the turbine building on 2 June 2007 and the cleanup of the leaked oil. On 7 June 2007, during start-up of the plant unit, a beginning fire was detected in the turbine building and the plant unit had to be taken back to hot standby state. In connection with shutdown of the plant unit, a reactor scram occured due to a malfunction in the reactor water level measuring. A small fuel leak was detected during the operating cycle preceding the outage. The leaking assembly was located and removed from the reactor.

The modifications implemented during the outage comprised piping replacements and modernisations due to system ageing. Two low-pressure turbines were opened, and cracks detected in inspections were repaired. Turbine drain lines and low-pressure extraction lines were replaced. A shutdown reactor cooling system valve was replaced with a valve of a new type, a generator rotor was replaced, and radiation monitoring system equipment of the exhaust gas system was replaced. The steam dryer that had been removed during the 2006 outage after being used for a year was reinstalled in the reactor, after repair during the operating cycle.

Hydroids were detected in the sea water systems of both plant units. The utility is looking for means to combat hydroid growth, as ample growth hampers water flow.

Annual maintenance outages

Based on its oversight, STUK determined that the annual maintenance planned and implemented by Teollisuuden Voima Oy was carried out safely. Needs for improvement were observed in modification planning schedules and compliance with the procedures. Attention must be paid to the management of changes to planned modification work concerning systems important to nuclear safety (e.g. decay heat removal). The impact of the changes must be assessed comprehensively.

Ninety-six working days during normal working hours were spent on-site on overseeing the annual maintenance outages of the Olkiluoto plant units. Two resident inspectors were also working on-site. In addition, a total of 66 inspection days outside working hours were spent on overseeing annual maintenance outages.

Plant maintenance and ageing management

The utility reports annually on the ageing of electrical and I&C components. The report describes the essential ageing phenomena subject to follow-up, the observations related to ageing and the actions necessary for lifetime extension. The observations are mostly related to the ageing of the structural parts of components, usually previously detected ageing phenomena under monitoring, such as whisker growth on zinc coated surfaces, wear of the sliding surfaces of position indicators in certain actuators, ageing of the comb material of certain types of relays and the ageing of the miniature relays of component control logics.

During the year, a new I&C ageing phenomenon was detected in potentiometers, which are used in the voltage sources of detectors for power range neutron flux measurement. Due to this, corrective action was initiated with the original supplier of the parts.

Repair and maintenance operations on electrical and I&C systems and components included the replacement of safety-classified batteries and valve actuators. The feature of the radiation monitoring system of the main steam pipes causing disturbances was repaired, and the exhaust gas radiation measurement system was replaced at each plant unit. A total of 11 rectifiers were replaced within the ongoing rectifier modernisation project at the plant units in 2007.

STUK reviewed the pre-inspection documenta-

Pressure equipment manufacturers and inspection and testing organisations

During the operating year, authorisations were granted to 25 pressure equipment manufacturers for the Olkiluoto plant (plant units Olkiluoto 1, 2 and 3). Fifty-three testing organisation authorisations according to Guide YVL 1.3 were granted. In addition, four testing organisations were authorised to conduct in-service inspections according to Guide YVL 3.8. One manufacturer authorisation and four testing organisation authorisations were withdrawn.

tion concerning safety-classified modifications and the feasibility studies of new components important to safety. During the year, Teollisuuden Voima Oy's inspection organisation made more than 60 commissioning inspections for safety-classified items in electrical and I&C systems. STUK reviewed the pre-inspection documents and supervised some of the commissioning inspections. During the annual maintenances, STUK supervised periodic inspections and the testing of electrical and I&C systems and components and certain improvement-related actions, such as actions to investigate the possibilities for removing disturbances in reactor water level measurement.

No significant observations related to ageing management were made during the annual maintenance outages at the Olkiluoto plant units. The in-service inspections of the reactor pressure vessel and the main steam pipes and feed water pipes were carried out as a duty of the licensee at both plant units according to Guide YVL 3.8. STUK's oversight included the approval of the inspection programmes prior to the inspections, oversight of the inspections and review of the results on-site. The final result reports are to be submitted to STUK for approval after the annual maintenance. STUK reviewed on-site the results of the condition monitoring inspections of the secondary circuit piping made by the licensee.

Fault indications were detected at Olkiluoto 1 in the sealing surfaces of one inner isolation valve of the main steam system, one relief valve of the blow-down system and one stop valve of the scram system. STUK approved for the faults to be monitored without repair. STUK required that the utility presents a plan for shortening the inspection cycle for the sealing surface of the main steam system valve and justifications for the selected inspection cycle. After the outage, the utility has initiated an investigation for replacing the valve and other similar valves (four valves per plant unit) at each plant unit in 2010–2011. Other significant operations included the inspections of the main steam valves and the replacement of their internals, servicing and inspection of relief valves and control valves of the blow-down system and the servicing of control rod actuators.

At Olkiluoto 2, the new reactor steam dryer manufactured by Skoda was reinstalled after the repair of the damage that had arisen during the first operating cycle (2005–2006). STUK approved the repair and installation. One of the isolation valves of the shutdown reactor coolant system was replaced. A similar operation was implemented at Olkiluoto 1 the previous year. A second item of similar valves will be replaced at each plant unit during 2008 and 2009. Fault indications were also detected at Olkiluoto 2 in the sealing surfaces of one inner isolation valve of the main steam system and one relief valve of the blow-down system, and STUK approved for them to only be monitored. The main steam valves, the relief and control valves of the blow-down system and the control rod actuators were serviced and inspected as at Olkiluoto 1.

No actual periodic inspections of pressure equipment were included in STUK's inspection area at Olkiluoto 1. However, two nitrogen tanks of the scram system were inspected. A total of 19 inspections in STUK's inspection area were carried out at Olkiluoto 2.

STUK carried out a total of 249 construction inspections and inspections of on-site repairs and modifications during the year, as well as four commissioning inspections.

Radiation safety

Occupational radiation safety

On the basis of documents submitted by Teollisuuden Voima Oy, STUK approved the use of the dosimetry system of the Olkiluoto nuclear power plant until 2011. As appropriate, the approval also covers the operational agreement between the utility and the Doseco company measuring individual doses at the power plant.

The dosimeters used for measuring the occupational radiation doses underwent an annual test, with acceptable results. The test comprises irradiating a sample of dosimeters at STUK's measurement standard laboratory and determining the doses at the power plant.

STUK carried out a radiation protection inspection according to the periodic inspection programme at the Olkiluoto power plant, covering the resources, expertise and operation of the radiation protection organisation. STUK required the Olkiluoto plant to develop further the radiation protection training and preliminary practising for maintenance operations.

STUK carried out radiation protection inspections during the annual maintenances at each plant unit. The plant has developed, e.g. the radiation measurements at the border of the monitoring area. Attention was also paid to the scope of and deviations in the use of protective equipment.

The manager of the radiation protection organisation at the Olkiluoto nuclear power plant changed in 2007. To a certain extent, the organisation also takes part in preparing for the implementation of radiation protection at Olkiluoto 3.

As part of the interim safety review, the utility will review the descriptions related to radiation protection at Olkiluoto 1 and 2 contained in the Safety Analysis Report in 2008 and 2009, and assess the occupational radiation protection actions in view of the comparative data received from similar nuclear power plants in Sweden.

Radiation doses

The collective occupational radiation dose was 0.26 manSv at Olkiluoto 1 and 0.92 manSv at Olkiluoto 2. The annual maintenance outage at Olkiluoto 2 was extensive in terms of both human resources and the amount of work. According to STUK guidelines, the threshold for one plant unit's collective dose averaged over two successive years is 2.10 manSv. This value was not exceeded at either plant unit. The collective radiation dose at Olkiluoto was clearly below average for BWRs in the OECD countries.

Occupational radiation doses mostly accumulate during annual maintenance at the power plant. The collective radiation dose of workers at Olkiluoto 1 during the outage was 0.17 manSv and that of workers at Olkiluoto 2 during the outage was 0.86 manSv. The radiation levels at the Olkiluoto 1 turbine plant decreased as the steam dryer of the plant unit was replaced during the 2006 outage. The moisture content of the steam flowing in the steam tubes and the concentration of radioactive substances carried by the moisture has decreased.

The individual radiation dose distribution of workers at the Loviisa and Olkiluoto nuclear power plants in 2007 is given in Appendix 2.

Radioactive releases and environmental radiation monitoring

The majority of the radioactive substances generated during nuclear reactor operation originate in nuclear fuel and the reactor cooling system, as well as the related purification and waste systems. The liquid and atmospheric effluents from the plant are purified and delayed so that their radiation impact on the environment is very low compared with the impact of radioactive substances normally existing in nature. The releases are carefully measured to ensure that they remain clearly below the prescribed limits. The calculated radiation dose of the most exposed individual in the vicinity of the plant has been less than one per cent of the set limit of 0.1 millisievert over the past few years.

Some of the measuring sensors of the weather mast at the Olkiluoto plant site are being replaced, and the acceptance testing of the sensors was witnessed at Vaisala Oy in 2007. STUK required that the plant in 2007–2009 assesses not only the development of the weather mast system but also that of the off-site additional measurements and the related predictive models with regard to the dispersion of any releases into the atmosphere.

The current programme for environmental radiation monitoring in the environment of the Olkiluoto power plant has been approved for 2003–2007. Experts at Teollisuuden Voima Oy and the independent laboratory carrying out measurements presented their experiences and development needs for the new period extending up to 2012. The programme will be submitted in its final form to STUK for approval at the beginning of 2008.

STUK reviewed the quarterly and annual reports concerning radioactive releases and environmental monitoring submitted by the utility. After discovering that a minor by-pass flow has been possible in the particle filter for the radiation measurement of releases into the atmosphere, the utility repaired the detected fault and reported the rectified data to STUK.

Table 5. Radioactive nuclides originating from the Olkiluoto plant detected in environmental samples in 2007.

Sample	Observed nuclides (number of samples)
Aquatic plants	Co-60 (11), Mn-54 (1)
Sediment	Co-60 (5)
Fish	Co-60 (1)
Mussels	Co-60 (2)
Seawater	H-3 (1)

Radioactive releases into the environment from the Olkiluoto nuclear power plant were well below authorised limits in 2007. Releases of radioactive noble gases into the air were approximately 0.1 TBq, which is approximately 0.0006% of the authorised limit. Releases of radioactive iodine isotopes into the air were approximately 15 GBq, which is approximately 0.01% of the authorised limit. Aerosol releases were approximately 30 MBq, tritium releases approximately 0.4 TBq and carbon-14 releases approximately 1.1 TBq.

The tritium content of liquid effluents released into the sea, i.e. 2.4 TBq, is approximately 13% of the annual release limit. The total activity of other nuclides discharged into the sea was 0.6 GBq, or approximately 0.2% of the plant-site specific discharge limit.

The calculated radiation dose of the most exposed individual in the vicinity of the plant was about 0.05 microSv, i.e. less than 0.1% of the set limit (Appendix 1, indicator A.I.5). The radiation emitted by natural radioactive elements in the soil of the environment of the plant causes a person outdoors to incur an equivalent dose in about 15 minutes.

A total of 307 samples from the environment of the Olkiluoto power plant were collected and analysed in 2007. A wide-ranging and comprehensive monitoring programme approved by STUK is being implemented in the environment of the nuclear power plant. The programme is extensive, and more than 300 samples are taken from air and terrestrial and marine environment surrounding the plant site each year. External background radiation and the radioactivity of people in the surroundings are also measured regularly. Extremely small amounts of radioactive substances originating in the nuclear power plant have been observed in some of the analysed samples. The detected concentrations were insignificant in terms of radiation exposure.

Emergency preparedness

Besides the periodic inspections of other operations, STUK controls the preparedness of the organisations operating nuclear power plants to act in abnormal situations. No such situations occurred at the Olkiluoto power plant in 2007.

Emergency preparedness at the Olkiluoto power plant meets the main regulatory requirements, which was determined in a periodic inspection held in September 2007. The inspection covered, among other things, the tasks of the action groups of the Olkiluoto power plant's emergency response organisation and the procedures and training for the construction sites of Olkiluoto 3 and Onkalo concerning the evacuation of personnel from the site in case of an accident at Olkiluoto 1 or 2.The licensee and the authorities have engaged in close co-operation. In 2007, training events on preparation for an accident at the Olkiluoto nuclear power plant were organised for the fire and rescue authorities throughout the area of the Satakunta regional rescue services and the personnel of the Provincial State Office of Western Finland.

Emergency exercises test the operation of the emergency response organisation, the functionality of the emergency response guidelines and the availability of the emergency response premises in practice, which are developed on the basis of the feedback received for the exercises. STUK also assesses the licensee's emergency preparedness during exercises. The emergency exercise at the Olkiluoto power plant was held on 28 November 2007.

Oversight of organisational operation

Safety management

In 2007, the operations of the Olkiluoto power plant were developed on the basis of feedback received from the World Association of Nuclear Operators (WANO) in 2006. The utility has become aware of the significance of management and leadership on the basis of both the feedback and its own operational analysis, and will make a significant investment in developing management over the next few years. In the autumn of 2007, the utility carried out a second self-assessment of its safety culture, applying IAEA's model. During 2007, STUK approved Teollisuuden Voima Oy's applications for changing the responsible manager and its organisation.

Based on inspections and the organisational oversight process, STUK is able to state that Teollisuuden Voima Oy is investing in the development of managerial work and pays attention to learning within the organisation. However, clearer objectives must be set for safety management and their attainment must be monitored to ensure continuous development.

Quality management system

Teollisuuden Voima Oy has maintained and improved the Olkiluoto power plant's quality management system according to its own plans. Several events occurred at the power plant in 2007 where deficiencies in quality management and quality assurance could be identified as underlying factors. The utility identified deficiencies related to guidelines, for example, through its event analysis process. The utility replaced its own assessment of the functionality and scope of its internal quality assurance activities by making an assessment against the reference levels concerning quality management defined by Western European Nuclear Regulators' Association (WENRA) and the WANO assessment carried out in 2006.

STUK controlled Teollisuuden Voima Oy's quality assurance system and its functionality through document reviews and inspections of the periodic inspection programme. Keeping the quality management system up-to-date will become even more challenging in the near future due to the inclusion of the construction project in the quality management system concerning the operating plant units and the continuously increasing organisational changes related to Olkiluoto 3.

Personnel qualifications and training

Teollisuuden Voima Oy is investing in personnel training. The utility has recruited more personnel and started human resource planning in view of the needs of Olkiluoto 3. The sufficiency of personnel has been challenging in the fields of reactor physics and electrical and I&C maintenance, in particular. The utility has paid attention to the transfer of silent knowledge and is allocating resources for this over the next few years.

The utility recruited four new operator trainees in 2007. STUK authorised 11 new shift manager trainees with two-year licences on the basis of written examinations. One person passed the oral exam and was authorised as a new operator. The operator licences of 19 people were renewed and one operator licence expired during the year.

The organisation is very different during annual maintenance. Teollisuuden Voima Oy has invested in the safety training of subcontractors and service providers and furthered awareness of the safety significance of their own work. Attention must continue to be paid to this as external workforce cannot assimilate all of the important information in a short period of time during training.

On the basis of inspections, licence hearings and organisational observations, STUK finds that Teollisuuden Voima is investing extensively in personnel training and development. However, the utility must pay attention to ensuring that the personnel has sufficient time to develop their expertise alongside their normal duties.

Over the next few years, Teollisuuden Voima Oy must invest in long-term human resource planning and prepare for managing the organisational changes in a controlled and safe manner. The utility must prepare for the generational shift by creating functional procedures for the transfer of knowledge from senior personnel to new hands.

Operational experience feedback

The Olkiluoto power plant has not seen any significant changes in the number of exceptional situations and operational transients over the past few years. In 2007, the power plant reported four exceptional situations. In the case of one event, the utility also conducted a separate root cause analysis, which revealed deficiencies in the management of amendments to the YVL guides, in ascertaining expertise and procedures concerning the entry of safety-classified components into the power plant. The events reported in special reports and their immediate causes were very different, but contributory factors were to some extent similar. The common factors are related to the management of the state of the plant and information, particularly in connection with changes. The utility has initiated a number of development actions aimed at ensuring that the components entered into the plant are in accordance with the designs and that their state and the guidelines are in compliance with the requirements.

Three reactor scrams took place at Olkiluoto 2, which were the most significant events in terms of nuclear safety at the Olkiluoto power plant in

Operational experience feedback

ERFATOM, composed of representatives of Teollisuuden Voima Oy and Swedish nuclear power plants, collects and pre-screens operational experience data based on reports from the World Association of Nuclear Operators (WANO), the Incident Reporting System (IRS), and NRC, the United States nuclear safety authority. Teollisuuden Voima Oy's Group for Operational Experience (KÄKRY) processes the utility's own and other plants' events by screening the events, as well as assessing the observations and their significance for various fields of technology. The group forwards reports for information, requests statements or gives recommendations to the responsible offices for further processing and decision-making concerning potential further action. In 2007, the team processed 136 events at the Olkiluoto plants, and required action to prevent recurrence in the case of 21 of these. Typical corrective action comprises changing instructions or procedures, providing training or implementing component modifications. In addition, the group reviewed 200 reports on significant events at other power plants. Teollisuuden Voima Oy also receives information on events at other power plants directly from sister plants (such as Forsmark), plant vendors and the co-operation group of BWR reactor operators (BWR-NOG).

2007. The number of scrams was also higher than normal. However, the causes of the scrams varied, and situations compromising nuclear and radiation safety did not arise. In addition, there were three other operational transients. The events had no significant impact on nuclear safety.

Internal processing and reporting is also required for low-level events or near-misses not subject to a special or operational transient report. Reports on such events are submitted to STUK for information if the event is or may be relevant to nuclear or radiation safety or STUK's communication activities. In 2007, Teollisuuden Voima Oy submitted three such event reports to STUK.

STUK controlled the operational experience feedback activities by reviewing the event reports submitted by the licensee and the annual summary of operational feedback activities. In addition, the periodic inspection programme includes an inspection dealing with international operational experience feedback activities.

This inspection showed that the utility has documented procedures in place for these activities and that the Olkiluoto power plant aims to improve the activities on its own initiative. A more comprehensive screening of IRS report was identified as a target for development. ERFATOM plays a significant role in the screening of operational events, but its screening criteria do not necessarily reflect the needs of Olkiluoto 3 in the future.

The Olkiluoto plant has systematic procedures and guidance for investigating and assessing the course and causes of events, and initiating corrective action. Any significant recurring events have not been evident among operational events over the past few years, but common features, such as those related to the management of modification operations, can be observed as underlying factors. The utility has identified and taken action on its own initiative to improve the procedures of operational experience feedback activities (the OPEX database). According to STUK's assessment, there is room for development in terms of the monitoring of the implementation of corrective action. Neither interconnection between minor deviations detected in operation nor specific equipment failures and operational experience feedback activities is obvious.

Spent nuclear fuel and low- and intermediate-level waste

STUK oversees the nuclear waste management of nuclear power plants through document reviews and inspections within the periodic inspection programme.

STUK carried out the inspections according to the periodic inspection programme at the Olkiluoto power plant. The inspection of low- and intermediate-level waste management focused on the labelling and treatment of active components stored in pools in the reactor building, the situation of waste management development projects, waste accounting, organisation and guidelines. The inspection of the final disposal facility for low- and intermediate-level waste dealt with the maintenance procedures for the concrete and rock structures of the final disposal facility. No significant deficiencies were detected in the inspections.

In 2007, maintenance waste below the activity limits taken to the local landfill for burial, waste oil delivered to Ekokem Oy, recyclable scrap metal and some reusable componenets were cleared from control with STUK's approval.

No significant events in terms of plant or environmental safety were evident in the treatment, storage or final disposal of low- and intermediate-level waste ("operating waste") at the Olkiluoto power plant. The volume and activity of operating waste in relation to generated electrical power remained relatively low compared with most other countries. The contributing factors include the high quality requirements for nuclear waste management and nuclear fuel, the planning of maintenance and repair operations, decontamination, component and process modifications, as well as waste monitoring and sorting, which enable clearing some of the waste from control. The power plant employs efficient procedures for reducing the volume of waste subject to final disposal.

Waste treatment and the waste systems have been subject to upgrading over the past few years. The bitumen-grouting system at Olkiluoto 1 was upgraded in 2007.

Safety case update for the final disposal facility for low- and intermediate-level waste

In accordance with the conditions of the operating licence, the safety case for the Olkiluoto final facility for low- and intermediate-level waste (the VLJ repository) was updated towards the end of 2006, considering the experience gained and the research completed over the repository's operating lifetime so far. The updated safety case includes the disposal of waste from Olkiluoto 3 in the VLJ repository. STUK reviewed the updated safety case in 2007 and submitted its statement to the Ministry of Trade and Industry towards the end of the year. In the review, STUK was assisted by external experts. STUK observed no deficiencies that would require immediate intervention in the implementation of final disposal.

Waste volumes

The volume of spent nuclear fuel on-site at the Olkiluoto plant at the end of 2007 was 6,750 assemblies (119tU, tonnes of original uranium) with an increase of 240 assemblies (42 tU) in 2007.

The volume of low- and intermediate-level waste on-site at the Olkiluoto plant at the end of 2007 was 6,124 m^3 with an increase of 112 m^3. Approximately 78 % of the waste has been disposed of.

4.3 Regulation of the construction of Olkiluoto 3

4.3.1 Overall safety assessment of Olkiluoto 3

The overall safety assessment of the new plant project is based on the observations made in the review of detailed designs, the oversight of manufacturing and construction, the results of the inspection programme during construction, the oversight of the plant vendor and its subcontractors, as well as the information and experience acquired as a result of interactions between STUK, Teollisuuden Voima Oy and the plant vendor.

On the basis of the review of detailed plans, STUK can state that the design has continuously become more detailed, but the plant vendor and the utility still have room for improvement in terms of submitting sufficiently detailed and unambiguous design documentation. STUK has required that the detected deficiencies in design documentation are corrected as the project progresses. In practice, this leads to changes and delays in design, particularly in cases where the safety requirements have not been taken into account correctly. The simultaneous progress of design and construction poses a special challenge to project management and supervision. When the design of certain process and I&C systems has progressed more slowly than the construction design and construction, in some cases it has been necessary to modify completed structures. So far, it has been possible to implement the required modifications in compliance with the original quality requirements. The management of modifications will be one of the key areas of STUK's oversight in 2008.

The manufacturers, the plant vendor and the utility have supervised the manufacturing of the primary circuit components appropriately. Manufacturing defects are still observed from time to time, but the detected deviations have been repaired in accordance with the plans presented to STUK so that the original approval criteria are met. As a result of the supervision of the manufacturing and construction of other components, the utility and the plant vendor have found deficiencies in their own operations and those of their subcontractors. Operational deficiencies have been dealt with at meetings between the plant vendor, the utility and STUK's project management and in connection with the inspections of the periodic inspection programme during construction and construction inspections at the manufacturers' premises. However, the results of the audits on the manufacturers and suppliers still showed that some of the actors have not taken the quality requirements of the nuclear field into account in their operation and remedying the situation has required setting project- and product-specific quality requirements. The number of such observations was lower than in previous years. The plant vendor and the utility must take the lessons learned into account comprehensively throughout the supply chain in order to further improve the efficiency of operations. STUK participated in some of the audits conducted by the utility and the plant vendor and, based on its observations, can state that the auditing activities have improved.

Based on the periodic inspection programme during construction, STUK was able to form an opinion on Teollisuuden Voima Oy's project management, resources, processing of safety issues and quality management, as well as the supporting functions. In the inspections made in 2007, STUK paid attention to the future phases of the project, such as installations and plant commissioning, and estimated the utility's preparedness in view of the needs. On the basis of the inspections, STUK demanded that the utility verifies the plant vendor's installation and commissioning procedures in good time. STUK required from the utility's project management that safety issues be monitored more systematically, that the links between safety issues and project phases be taken into account in decision-making and that decision-making and monitoring are traceable. STUK paid attention to the project management's operation when processing product and operational deviations, and expects more systematic processing of the deviations by the project management in order to ensure that the plant complies with the requirements. The utility has presented action plans concerning the development needs found in the operations, and STUK will monitor their realisation during the project. In conclusion, however, it can be noted that the utility is attempting to improve the efficiency of project management. Examples of this include the systematic personnel training activities and the increase in the resources supervising the plant vendor's operation, assessing design and supervising construction and manufacturing.

The assessment of the plant vendor by STUK is based on the assessment of operation in connection with oversight on the construction site and at component manufacturers' premises, reviews of the documents drawn up by the plant vendor, the review of the plant vendor's quality management system and plans and the review of the project manuals, as well as inspections of operation and interactions with the plant vendor at meetings. Co-ordinating the project schedule and design as well as construction pose challenges to the plant vendor. STUK's experiences show that the plant vendor is, however, prepared to repair the detected design and quality defects in accordance with the original quality requirements. STUK expects the management of subcontractors and the construction project to improve further as a result of the inspection observations, such as those related to the manufacturing of the steel liner.

Based on the results of oversight, STUK is able to state, despite the modifications to design and the deficiencies detected in construction and manufacturing, that the original safety and quality objectives for the plant can be achieved. So far, the plant vendor has been able to take the design modifications into account in construction, and the deficiencies detected in manufacturing have been repaired so that the original quality requirements are met. The deficiencies in the operation of the various parties and quality have caused additional delays in project implementation and resources have been occupied in processing the problems. STUK will continue project oversight according to the current policies. On the basis of the results of oversight in 2007, STUK has decided that the key areas for oversight in 2008 will be the quality management of the various parties and design and construction site modifications. The interfaces between the project schedule, design and simultaneous construction, and the component installations that will begin in 2008 pose increasing challenges to oversight.

4.3.2 Oversight and observations

During 2007, STUK reviewed the detailed design of Olkiluoto 3 and oversaw component manufacturing at manufacturers' premises and plant construction at Olkiluoto.

Review of design documents

Conceptual plant design

Of the conceptual design documentation of Olkiluoto 3, the utility submitted the general design objectives in case of internal and external threats, among other things, to STUK for review. The documentation presents the separation principles applied to minimise the consequences of internal threats, such as flooding and fire, between the safety system subsystems (divisions). In addition, the concept of monitoring leaks outside the containment was described. The document review revealed issues that the utility and the plant vendor must clarify in more detail.

An updated plan for the separation and location principles for electrical and I&C cabling was submitted to STUK for review. Among other things, the plan presented modified solutions for the separation of the cabling of different subsystems. The modifications will improve the fire safety of the plant. In 2007, STUK reviewed documents on the electro-technical dimensioning of electrical systems and made remarks concerning the clarification of the behaviour of the plant's electrical systems during design basis electromagnetic disturbances.

In 2007, STUK reviewed the additional testing plan drawn up to prove the electromagnetic compatibility (EMC) of the electrical and I&C system components. The testing aims to show that the portable DECT phones to be used at the plant will not interfere with electrical and I&C components important to safety. STUK required that the phones of the authorities' radio network Virve can be used indoors at the plant.

Transient and accident analyses

Teollisuuden Voima Oy submitted to STUK for approval accident and transient analyses concerning the plant's behaviour related to a break in a large reactor coolant line and piping breaks in the steam generator heat exchanger. The review of these analyses will continue in 2008. The preliminary review by STUK did not give rise to any significant observations with an impact on plant design. To support the review, STUK commissioned independent assessments related to accidents from VTT, the Technical Research Centre of Finland. STUK commissioned VTT to further develop the models necessary for analysing the plant's behaviour. In 2007, the models were developed to reflect the detailed design of the plant. Through model development, STUK is preparing for the review of the analyses at the operating licence phase.

Probabilistic risk analyses

In 2007, STUK assessed how the principles influencing reliability are implemented in the detailed design documents on systems and structures. The objective was to ensure the adequate reliability of preparation for local events (such as fires and flooding on-site), in particular. Accordingly, the assessment focused on interdependencies between systems and possible tendencies for common-cause failures. The review of I&C system design focused on the adequate application of the diversity principle against common-cause failures.

The third update of the PRA model was submitted to STUK for information. Of the PRA applications, STUK reviewed the update of the method description of the risk-informed periodic testing programme. In addition, STUK is reviewing the method description of the risk-informed periodic piping testing programme, the risk-informed regular inspection programme for Safety Class 2 piping, the method description of flood risk analysis, and the method description of the use of PRA when drawing up the Technical Specifications.

Fire and flood analyses

STUK reviewed the deterministic fire and flood analyses for Olkiluoto 3 buildings and rooms. Studies on the fire properties of the novel-type fire retardant non-corrosive (FNRC) cables to be used at the plant were commissioned from VTT. In relation to this, STUK commissioned an analysis of fire in a large cable room from VTT. According to the results of the analyses, the structural fire protection at the plant is adequate. The review of the parts of the flood analyses is still incomplete. However, the results make it possible to state that the design provides adequate provision for leakage situations inside the plant.

Analyses concerning buildings

STUK reviewed analyses of aircraft impact aimed to show that impact will not cause vibrations fatal to the components and structures of the building. The reviewed analyses concerned the reactor, fuel and safeguard buildings. STUK also reviewed strength and stress analyses concerning aircraft impact walls and other key structures.

Radiation safety

The utility submitted the updated requirements specifications and the quality plan for radiation measurement systems to STUK for approval. The review of the documents will continue in 2008. STUK reviewed compliance with the radiation protection requirements for the structures of the reactor, fuel and safeguard buildings. The radiation protection of the fuel pools was improved by adding a steel lining to the concrete surrounding the pools.

The independent comparative analysis of radioactive releases in connection with severe accidents at Olkiluoto 3, commissioned by STUK from VTT, was completed. STUK employed the analysis when reviewing the corresponding analyses submitted by the utility. STUK also reviewed the report on radiation protection at Olkiluoto 3 in accident conditions submitted by the utility and made remarks on it.

STUK reviewed the requirements for systems' radiation safety, such as radiation protection, distances between components, accessibility and decontamination. This review was part of the pre-inspection of process systems.

Systems planning

STUK continued the review of the detailed design of process systems in 2007, and the process design of the systems most significant to safety was approved. In addition to systems planning, STUK reviewed the load specifications related to system piping planning. These will function as initial data for the detailed piping design. The review of the I&C and electrical design of process systems will continued in 2008.

STUK reviewed the updated power supply system designs for the reactor plant and the turbine plant. The majority of the designs to be updated on the basis of STUK's remarks will be submitted in 2008. STUK continued to review the frequency and voltage limits to be applied in process planning. No significant deficiencies were found in the reviews. In addition, STUK continued the review of the fault analyses for programmable electrical components on the basis of the report submitted to STUK, justifying the differences between the components.

The utility submitted the technical and functional requirement specifications, quality plans and system descriptions for the main I&C systems to STUK for review. It was found, based on the review, that some of the documents are too general, and STUK required that they be made more specific. STUK reviewed the design requirements for the electrical isolation of the main I&C systems and required electrical isolation of protection I&C from other I&C systems. STUK assessed the software design, the lifecycle of I&C systems design and the scope of testing. Regular inspections of the in-service inspection programme pertaining to the comissioning of mechanical components at Olkiluoto 3 are to be made using methods qulified in accordance with Guide YVL 3.8. With regard to the testing procedure for I&C systems, STUK required extending the tests to ensure the working of the I&C systems as a whole, instead of individual I&C systems. In addition to the review of the main I&C systems, STUK reviewed individual I&C systems, such as those of the fuel handling systems.

Design of components and structures

In 2007, the reviews of the detailed component design focused on the manufacturing plans for the main components (the reactor pressure vessel and steam generators with their internals, the pressuriser, reactor coolant pumps, main coolant piping and control rod drive mechanisms). Reviewing the construction plans of other mechanical components was continued by STUK and inspection organisations authorised by STUK. STUK reviewed the plans for components such as the emergency cooling system pumps, fuel handling equipment, the refuelling machine and the polar crane and the most important valves. The review of the plant piping planning was also started. STUK reviewed the material and manufacturing documents of the most important piping and the isometrics of piping. Due to the large amount of piping documentation, STUK employed consultants for assistance in its review. No significant design deficiencies were revealed in the review.

In 2007, STUK reviewed the specifications of components related to safety-classified electrical systems that provide the basis for component procurement and manufacturing. STUK put forward the inclusion of requirements mainly related to the components' capability to withstand electromagnetic disturbances. STUK reviewed the structural plans of process pump motors. STUK made remarks on the content of the structural plans, related to such issues as the environmental conditions of the motors and supervision and tests during their manufacturing. In addition, the structural plans of the diesel motors and generators intended for power supply in external grid loss situations were reviewed. The review will continue in 2008.

No component-level documents for I&C components were submitted to STUK for review in 2007.

The handling of fuel licensing documents continued with the review of fuel fabrication documents.

Ageing management

The ageing management of the main components and other safety-significant mechanical components is based on the choice of structural component materials and high-standard manufacturing technology. STUK has paid attention to this issue in connection with the oversight of structural plans and the manufacturing of the main components. During plant operation, the ageing of the components will be controlled through periodic inspections. STUK approved the summary programme for the in-service inspections according to Guide YVL 3.8 submitted by the utility. The plant vendor and Teollisuuden Voima Oy have launched the qualification of inspection methods, and STUK has reviewed initial data documentation for the qualifications.

In connection with the review of the Preliminary Safety Analysis Report, STUK required that a preliminary ageing monitoring programme be drawn up for electrical and I&C systems and components during the construction of the plant unit. Component procurement is still in progress, and the programme has not yet been submitted to STUK.

Component qualification and proving feasibility

The utility submitted to STUK updated reports on the qualification of mechanical, electrical and I&C components for accident conditions. STUK processed the reports and substantially approved the presented pressure and temperature conditions during accidents to be used for component qualification. STUK required the utility to clarify further such issues as the radiation conditions during accidents in certain buildings and the conditions in severe accidents. The utility submitted more specific reports to STUK towards the end of 2007. Their review will continue in 2008.

Design modifications

Documentation on the handling of steam generator heat exchanger tube break accidents was submitted to STUK. The modification in accident management aims at preventing the dilution of primary circuit water and ensuring the nuclear criticality safety of the reactor and minimising releases. The review of the documentation related to the modifications by STUK will continue in 2008.

The plant vendor proposed modifications to the power supply systems. The modifications concerned securing uninterrupted power supply so that power may be supplied to consumers through another route in addition to the inverter supply. The malfunction at the Forsmark nuclear power plant in 2006 is behind the modification.

STUK required electrical isolation between I&C systems to prevent potential electromagnetic disturbances in lower safety class systems from causing disturbances in the higher safety class systems. The utility and the plant vendor submitted a proposal on the separation of the protection I&C from other systems. The review of the documentation will continue in 2008.

The utility submitted a conceptual description of the installation of room-specific leak monitoring in safety-significant rooms to STUK. The modification aims at accelerating the detection of potential leaks, the identification of leak routes and the stopping of the leak to minimise releases. The review of the documentation will continue in 2008.

STUK discussed the securing of the nuclear criticality safety during refuelling with the utility and the plant vendor. The plant has been designed based on the assumption that essential fuel charging errors in terms of nuclear criticality safety can be precluded by administrative procedures. STUK required structural safety in addition to administrative procedures. The handling of this issue will continue in 2008.

Oversight of design and construction

The oversight of component manufacturing focused on the inspections of the main components. STUK's inspector supervised by regular monthly visits the manufacturing of the reactor pressure vessel at the factory of Mitsubishi Heavy Industries in Japan and the manufacturing of steam generators at the plant vendor's factory in St. Marcel in France. The manufacturing of other components, such as the pressuriser and reactor coolant lines, was also witnessed in connection with the visits. The manufacturing of the reactor coolant pumps and the control rod drive mechanisms was supervised by regular visits to the plant vendor's factory in Jeumont, France. The manufacturing of the internals of the reactor pressure vessel was supervised at Skoda's Pelzen factory in the Czech Republic, and the manufacturing of the steel liner ensuring the leak-tightness of the containment was supervised at Energomontaz Polnoc Gdynia's premises. Through its oversight, STUK aims to verify the operation of the manufacturers, the plant vendor and the utility, and ensure the compliance of the products with the requirements.

The manufacturing of the new batch of reactor coolant lines was a particular focus for manufacturing oversight. Towards the end of the year, Teollisuuden Voima Oy and the plant vendor presented preliminary results concerning the line properties to STUK. The results showed that the grain size of the line material was more uniform and the lines could be inspected using ultrasonic methods. The availability of a suitable inspection method for the line material was also assessed by STUK together with its consultant at the manufacturer's premises. The results were in line with the plant vendor's results. The review of reports related to this issue will continue in 2008.

Construction oversight focused on the manufacturing and installation of Safety Class 2 steel and concrete structures. STUK inspected the readiness to start the concreting of Safety Class 2 concrete structures and authorised the start of concreting. The concreting was successful. Installations important to safety also started at the construction site. For example, parts of the steel liner to be installed on the surface of the inner containment were welded in the summer of 2007. The first tanks and piping were installed in the containment. STUK also inspected the elements inserted into the concrete casting, such as steel structures, grip plates and piping prior to their installation.

Repairs of components and structures

Some items requiring repair have been observed in connection with the manufacturing of the main components (e.g. welding and manufacturing defects). Welds have been repaired in accordance with approved repair plans, and the original quality requirements have been met. The heat treatment of a repair related to the feed water assembly of one steam generator failed, due to which the entire assembly had to be replaced. The manufacturing of reactor coolant lines was resumed after STUK approved the line manufacturing programme. The first new lines were completed towards the end of 2007.

In the summer of 2007, quality defects were detected in the weld between containment steel liner parts, as well as defects in the form of the steel liner. The root causes for the failure of the weld were found to include that the diameters of the large cylinders with thin walls joined together by welding were slightly different, the welding conditions changed during the operation and errors were made in the welding. The defects in the form of the welded structure were repaired by cutting off the erroneous parts and welding on new parts to replace them. To ensure the quality of the weld, it was X-rayed in its entirety in a post-repair inspection. Corrective action to ensure the quality of other similar welds included the modification of the welding method and the development of supervision.

Oversight of the preparations for plant operation

Teollisuuden Voima Oy continued the recruitment and training of personnel needed to operate Olkiluoto 3. In 2007, more than 200 people participated in training to prepare for plant operation. STUK inspected the utility's training activities. The inspection did not reveal any substantial deficiencies in training activities. The utility managed to maintain a good learning atmosphere and to ensure information dissemination between the different parties involved in the training of operating staff.

STUK approved the general structure of the plant's Technical Specifications, and the plant vendor started the detailed writing work. STUK controlled the preparations for operating manuals and reviewed the structure of the manuals. The structure also included instructions for disturbance and emergency situations. STUK required more detailed clarifications on the scope of the operating instructions and the additional analyses to be conducted to support the drafting.

Oversight of organisational operations and quality management

STUK assessed the operation of the organisations taking part in the Olkiluoto 3 project in accordance with the periodic inspection programme during construction. In addition, operations were observed by participating in audits conducted by Teollisuuden Voima Oy and in connection with document reviews, construction inspections of components and structures, and construction site rounds. STUK's observations showed that the problems detected previously in the course of the project in terms of the co-ordination of the progress of plant design, manufacturing and construction, compliance with the set quality requirements and guidance of subcontractors continued. Problems with the co-ordination of work and a feeling of haste hampered working.

There were still deficiencies in the content of the plant design documentation submitted to STUK. As the deficiencies passed the review of both the plant vendor and the utility, there is still room for improvement in the review activities of both of them. Due to the deficiencies, STUK could not approve the submitted documents as such, but requested additional clarifications to design information. Common deficiencies in the documentation included using imprecise expressions in the definition of design requirements, references to wrong reference documents and ignoring or responding superficially to STUK's requirements. The plant vendor also had to modify the designs due to neglecting to take some safety requirements into account. The utility increased the resources needed for reviewing the design and manufacturing documentation due to the feedback from STUK.

The management of modifications is critical in the project as the construction design and construction of the plant are proceeding at different phases compared with the other fields of engineering. Modifications were necessary on the construction site in terms of the support of process system components, for example, as the requirements of the process were not fully anticipated in previously designed structures. STUK has required that timely information dissemination, decision-making and co-operation between the different fields of engineering (construction, process, electrical and I&C engineering) is ensured more efficiently in the project. In 2008, STUK will focus its oversight on modification management during the installation phase.

The adequate supervision and guidance of subcontractors was still challenging for construction and manufacturing on site. One indication of this was the welding failure in the steel liner of the inner containment, mentioned above. The guidance and supervision of subcontractors was deficient; the co-ordination of work was inadequate, which led to unfavourable welding conditions, the work supervisors were not aware of the nuclear safety requirements underlying the quality requirements for the work, and the supervision of the work was inadequate. Due to the event, STUK paid special attention to welding operations and their supervision on the construction site during the summer. As a result, room for development was found in terms of compliance with welding instructions, the management of welding instructions and materials and the supervision of welding, as well as quality inspections. In addition, STUK required that clear requirements for acceptable work be made known to all parties and that the utility and the plant vendor ensure that subcontractors understand the safety significance of their work in order to achieve a high-quality outcome. The utility and the plant vendor increased the resources for construction site supervision, developed the supervision instructions and provided training on the significance of supervision.

Component manufacturing mostly proceeded well, and any problems and quality defects in manufacturing were detected by the manufacturer, the plant vendor or the utility. In some cases, the rush in component assembly led to situations where the manufacturer and the plant vendor anticipated the times of STUK's construction inspections so much that the prerequisites for inspection were not present and the inspections had to be rescheduled. STUK required the utility to ensure in the future that the prerequisites for inspection are present. In early 2007, it was detected that the manufacturing of the diesel generators was started before the relevant plans had been approved. A similar observation concerning the start of manufacturing was made in the case of some electric motors. In both cases, the plant vendor interrupted manufacturing, which was not resumed until the plans had been approved. STUK required the utility to report on the component manufacturing situation and the approval of plans. Early in the year, the utility encountered difficulties in acquiring information on the different phases of component manufacturing, which was due to the large number of components and problems related to the launch of reporting.

The observations concerning the operation of organisations and quality management show that the difficulties in quality management in the construction of Olkiluoto 3 continued. Even though the quality management of the subcontractors taking part in the construction and manufacturing operations for Olkiluoto 3 was mostly of a high standard, the observed operational deviations and the defects detected and repaired in the products show that the situation was poorer with some of the subcontractors. The subcontractors' work was hampered by deficiencies in the management of materials, documents and working methods, for example. Several subcontractors improved their operations due to the feedback, and quality management developed positively. The inefficiency in the reporting and handling of quality deviations and their utilisation was a general deficiency that still affected both the utility's and the plant vendor's quality management. STUK required in 2006 that the utility and the plant vendor develop deviation processing. Teollisuuden Voima Oy launched the systematic classification of deviations and monitoring of the deviation trend in 2007. The efficient processing of deviations and their systematic utilisation will be key areas in STUK's oversight of quality management in 2008.

As a positive observation, STUK found that the utility and the plant vendor are willing to develop their operations in order to supervise design, construction and manufacturing and make project management more efficient. For example, Teollisuuden Voima Oy has a high-standard internal familiarisation programme, and the resources of design, manufacturing and construction supervision have been constantly increased.

4.4 FiR 1 research reactor

The FiR research reactor continued to operate in 2007 as in previous years.

There were no exceptional events affecting safety, and occupational radiation doses and radioactive releases into the environment were clearly below the set limits.

In 2007, radiation therapy sessions were provided twice a week as necessary at the research reactor. In addition, the operations included research-related isotope irradiation commissioned by external enterprises and basic training in reactor physics.

STUK regularly assesses and reviews the documents on the FiR 1 reactor required by the Nuclear Energy Decree. In 2007, VTT, the Technical Research Centre of Finland, revised the nuclear safeguards manual and the changes were approved by STUK.

STUK carried out inspections on the operational safety, physical protection and emergency preparedness, nuclear material safeguards and radiation protection of the FiR 1 reactor. In its inspections, STUK set requirements concerning physical protection, among other things, whose implementation will be monitored.

VTT must pay special attention to the renewal and training of the research reactor staff. The personnel and training plan drawn up on the key duties of the reactor operating staff concerns the training and transfers of the production manager, the persons responsible for physical protection, nuclear material issues and emergency preparedness, as well as fire and radiation protection tasks over the next few years. An additional person is needed for supervisory reactor operation duties. One of the current operators will take up this task after further training. The regular renewal of operator licences applies to several operators in 2008.

The nuclear safety of the FiR 1 reactor, the condition of its structures, systems and components, as well as the human resources and the related operating plans are sufficient for continued operation.

4.5 Preparation for new projects

Environmental safety assessments for new nuclear power plants

STUK submitted statements to the Ministry of Trade and Industry on the environmental safety assessment plans of new nuclear power plant projects: Teollisuuden Voima Oy's Olkiluoto 4 reactor in Olkiluoto, Eurajoki, and the Loviisa 3 reactor in Hästholmen, Loviisa.

Feasibility studies for new nuclear power plant projects started

In 2007, Teollisuuden Voima Oy started feasibility studies on different power plant alternatives for an application for a decision-in-principle. From the nuclear safety perspective, the purpose of the feasibility study is to assess how the plant alternatives comply with the Finnish nuclear safety requirements. A key objective for the work is to identify those design features in the plant types that must be developed to achieve compliance with the Finnish requirements. At the request of Teollisuuden Voima Oy, STUK has participated in the technical discussions between the utility and plant vendors. Fennovoima Oy (FV), the new actor, contacted STUK in order to start similar feasibility studies, and requested STUK to begin giving preliminary instructions in accordance with section 55 of the Nuclear Energy Act. Discussions on the feasibility study with Fennovoima Oy started towards the end of the year. Fortum Power and Heat Oy presented a request to begin discussions on preparing an application for a decision-in-principle at the end of the year.

5 Nuclear waste management regulation

STUK's regulatory control of nuclear waste management covered the following spheres in 2007:

- management of low- and intermediate-level waste generated in power plant operation (minimisation of waste generation, collection, treatment and conditioning, segregation, decontamination, volume reduction, solidification, packing, measurements, storage, transfers, final disposal, clearance from regulatory control, accounting and reporting, the quality system; see sections 4.1 and 4.2 above)
- storage of spent fuel (see sections 4.1 and 4.2 above)
- the spent nuclear fuel disposal project
- other nuclear waste management programmes.

5.1 Oversight of the spent nuclear fuel disposal project

From the perspective of nuclear energy legislation, the spent nuclear fuel disposal project may be broken down into five main stages:

1. *research stage:* from the 1970s to the Government decision-in-principle
2. *site verification and research construction stage:* from the decision-in-principle to the construction licence
3. *construction stage:* from the construction licence to the operating licence
4. *operating stage:* from the operating licence to decommissioning
5. *terminal stage:* from decommissioning to the termination of the licensee's waste management obligation. When the final disposal of nuclear waste has been carried out acceptably, the licensee's waste management obligation ends and the responsibility for the nuclear waste disposed of is transferred to the State.

In 2007, the final disposal project and the related oversight activities by STUK were at stage 2, the "site verification and research construction stage". The reorganisation, reallocation and refocusing of the oversight continued with high priority in accordance with STUK's strategy and the nuclear waste management operating plan.

In 2000, the Government issued the decision-in-principle, as required in the Nuclear Energy Act, stating that the final disposal of spent nuclear fuel in the bedrock at Olkiluoto is in line with the overall good of society. Parliament ratified the decision in May 2001. The decision-in-principle states that the spent nuclear fuel disposal project may proceed to the construction of an underground rock characterisation facility and more detailed investigations. This statement indicates how far the implementation of the final disposal project may proceed pursuant to the decision-in-principle, taking into account that the underground research facility referred to in the decision-in-principle is intended to be used as a part of the final disposal facility to be constructed later.

In addition to the construction of the underground rock characterisation facility, the decision-in-principle specifically mentions more detailed investigations; in other words, the Government and Parliament have required that research, development and design activities should be continued in order to specify the safety case further.

The actions taken by Posiva Oy, the applicant for the decision-in-principle, to implement the decision are governed by the Nuclear Energy Act and fall under STUK's regulatory control. In 2007, the final disposal project progressed in accordance with the decision-in-principle. In the year under review, the control of the final disposal project comprised:

- oversight of the underground rock characterisation facility construction (ONKALO oversight),
- review and assessment of the R&D and technical design activities to further specify the safety case for final disposal (R&D and design oversight), and
- regulatory control related to nuclear non-proliferation pertaining to the research facility (the regulatory control of nuclear non-proliferation that ensures that in the implementation of the ONKALO project, there is no room for doubt that Finland fulfils her duties concerning nuclear safeguards, now and in the future, see Chapter 6).

5.1.1 Oversight of rock characterisation facility construction (ONKALO oversight)

Overall safety assessment

The construction of Onkalo is proceeding on schedule. The construction may affect the long-term safety of final disposal by changing the properties of the bedrock and groundwater surrounding the repository. The safe implementation of final disposal activities also requires that the facility is designed taking into account occupational safety aspects. The impact of the construction of Onkalo has been monitored by means of various measurements, and the criteria derived from long-term safety assessment have not been exceeded. No factors compromising safety have been detected in the design and implementation of the structures and systems important to safety.

Oversight and observations

STUK oversaw the construction of the underground rock characterisation facility (Onkalo) by reviewing Posiva's design documentation and performing inspections on the construction site. In 2007, the oversight focused on rock sealing, the management of inflows that could change the groundwater conditions, and foreign materials (e.g., concrete) used in the excavation of Onkalo that could have a detrimental impact on chemical conditions and thus impair long-term safety. The operation of organisations was also assessed by means of inspections in 2007, and the inspection of Posiva's management and quality system was started.

Oversight of design and construction

STUK revised the oversight of the construction of Onkalo in 2007. The construction inspection programme (RTO) provided a framework for the oversight activities. STUK reviewed and approved Onkalo's safety classification document, submitted to STUK for the first time. The document presents the classification of systems, structures and components in accordance with their safety significance. As a result of the review, STUK required Posiva to submit a revised document, which must provide a more extensive description of the analysis of safety significance on which the classification is based, and be supplemented in other regards to comply with STUK's requirements.

The construction of Onkalo involves many design and as-built documents at different phases that STUK reviews. In 2007, STUK laid down requirements related to these and their delivery, covering organisational issues, the regulations, guidelines and standards to be applied, the initial data used in design, design drawings, construction documents and as-built documentation, and the related schedules and notification of deviations to STUK.

During the year under review, STUK completed the review of the basic construction documentation referred to in section 35 of the Nuclear Energy Decree, concerning the preliminary safety analysis report, the classification document, quality assurance, physical protection and emergency preparedness and safeguards of nuclear materials, and found them sufficient in terms of scope and content.

STUK reviewed the geological mapping data on Onkalo's access tunnel from 1,300 metres to 2,350 metres. The aim of the review is to ensure sufficient scope and correctness of the mapping data.

Oversight of the organisation and procedures

STUK's oversight of Posiva's organisation comprised inspections on project management, handling of safety issues and construction procedures. Based on the inspections, STUK required improvements in the instructions and written procedures concerning the construction of the rock characterisation facility, concerning, e.g., procedures for handling deviations, action thresholds in the quality assurance guidelines and ensuring the competence of personnel.

STUK started the inspection of Posiva's management system in the autumn of 2007, which is to be completed in May 2008. The content and implementation of this inspection was revised to correspond to the inspection of the management system of an organisation responsible for the construction of a nuclear facility.

STUK also oversees Posiva's subcontractors based on the safety significance of their work. STUK observes their activities through inspections, by participating in audits conducted by Posiva, and in connection with document processing, meetings, construction inspections of components and structures, and construction site and laboratory rounds.

5.1.2 Assessment and review of research, development and design activities to further specify the safety case for final disposal (R&D and design oversight)

The oversight of R&D and design activities comprises independent assessment of Posiva's activities and their results, forming an opinion of them and, as necessary, guidance and formulation of requirements as well. STUK attempts to ensure that as good a result as possible is achieved as certainly as possible. This objective and ultimately the quality of Posiva's performance determine how STUK acts in terms of the oversight of R&D and design activities at any given time.

STUK's oversight of R&D and design activities comprise reviews of the current documentation for the safety case of the final disposal facility, comparative analyses, identification of open safety issues and inspections of Posiva's and its subcontractors' management and quality systems. In 2007, STUK reviewed more than 100 reports delivered by Posiva. STUK also initiated four extensive assessments supported by external expert teams, two of which were completed in 2007.

Encapsulation and final disposal

STUK's internal and external resources in this field were both increased substantially during the year, based on the principle that key expertise must be available in STUK's own organisation and that independent external expertise and technical support for conducting safety assessments and practical inspections will be acquired as necessary. During the year, STUK recruited experts e.g. on encapsulation techniques and the bentonite buffer, and set up an international team of experts focussing on final disposal technology to support the processing of safety issues.

The design of Posiva's encapsulation and final disposal facilities has progressed based on long-term planning. The plans of the preliminary design stage were completed towards the end of 2006. STUK reviewed the plans and documentation included in more than twenty reports. The objects of review included the design and construction of the repository, the systems monitoring how the construction of the repository affects the safety-significant properties of the bedrock, the encapsulation and final disposal process, systems planning, systems' safety classification, the layout of the facilities, rock and concrete construction, fire compartmentalisation and fire safety, radiation protection design, radiation classification, radiation monitoring, the closing of the repository and waste treatment. The review was mostly carried out in 2007, and the assessment was finalised in early 2008.

In 2007, STUK held two meetings with Posiva concerning technical barriers to deal with the safety issues brought up by STUK. The follow-up list of safety issues was revised towards the end of 2007.

STUK prepared a review of the waste canister design report and its background reports, published in 2005, which was submitted to Posiva and the Ministry of Trade and Industry for information. The review raised issues whose resolution STUK will follow while Posiva's development work progresses.

STUK's oversight also covered Posiva's development work on waste canister manufacturing techniques, which Posiva has continued in co-operation with the Swedish nuclear waste company SKB. Using the pierce-draw method, which is Posiva's responsibility, two copper canisters were manufactured in Germany in 2006. The objective of the manufacturing tests was a sufficiently small copper grain size and a homogenous microstructure in the canister's walls and bottom. These objectives were attained.

STUK also oversees the development work on copper canister welding. Posiva has continued copper canister lid electron beam welding tests in co-operation with Patria at the Linnavuori factory in Nokia, and has made distinct progress in welding technology development. In 2007, the electron beam welding tests focused on developing new electron beam control and measuring equipment, improving and characterising the quality of welding, the preparation of preliminary welding instructions and welding modelling (heat transfer).

In 2007, STUK oversaw the development of waste canister inspection techniques, which Posiva has performed in co-operation with VTT Research Centre of Finland and SKB, among others. Posiva has also continued planning the inspection qualification procedure. In 2007, issues related to non-destructive testing methods (NDT) included the drafting and development of inspection guidelines, the definition of preliminary approval criteria (acceptable defect sizes), and the reliability and modelling of NDT methods.

STUK also oversaw the R&D and design activities related to the bentonite buffer. Posiva continued the planning of the BENTO project, the development project begun in 2006 to investigate issues related to the performance of bentonite and to develop manufacturing and installation techniques as well as domestic expertise in the field. In 2007, Posiva began developing manufacturing methods for bentonite blocks, which heretofore has been carried out under SKB's lead in Sweden. The R&D work on tunnel backfilling techniques is being carried out in co-operation with SKB within the Baclo project, which has progressed to its third phase.

Posiva, together with SKB, completed the KBS-3H project developing the horizontal disposal of waste canisters in 2007. Posiva will finalise the report on the development project in early 2008. Posiva and SKB will then decide on the further development of this alternative disposal concept on the basis of the results. STUK will review the KBS-3H documents in 2008.

Verfying site investigations

Posiva delivered to STUK the extensive "Site 2006" documentation concerning the repository site at Olkiluoto, which STUK reviewed with the assistance of both Finnish and international experts. The aim of the site investigations pertaining to the documentation is to investigate and describe the current state of the bedrock, its development to the current state, and the impact of the construction of Onkalo on the bedrock and its safety-significant properties and their preservation. The documentation provides some of the essential bases for a site-specific safety analysis.

STUK's safety assessment dealt with the issues important to safety, such as:

- research and data acquisition methods and research materials
- geology: descriptions of rock types and their alteration, the volumes and shapes of rock types, fault and fracture zones, fracture minerals and the geological model
- rock mechanics: rock stress, physical properties, thermal properties, the mechanical stability of the bedrock
- hydrogeology: groundwater salinity, hydrostatic pressure, hydraulic conductivities, groundwater level measurements, definition of the hydrogeological zones, groundwater flow models
- hydrogeochemistry: chemical parameters of groundwater, the representativeness of samples, microbial effects, buffer capacity, groundwater salinity, solute methane, groundwater mixing ratio, the groundwater chemistry model
- modelling of groundwater flow and salinity development
- prediction of Onkalo's properties and the impact of construction.

STUK's concluded in its review that the repository site surveys and investigations described in the documentation have attained the objectives set for this stage. The review report delivered to Posiva also included a number of safety issues where additional reports and work were considered necessary.

Meetings with Posiva to comprehensively review the safety issues concerning the repository site were held every six months. Members of STUK's team of international experts also participated in these meetings.

During the year under review, STUK updated the follow-up list of open safety issues related to the repository twice, with the assistance of an external team of international experts.

STUK's oversight also covered the four new deep holes drilled by Posiva in the research area, where geophysical and hydrological research was conducted. One research excavation was mapped for fractures, rock type distribution and degree of alteration.

In 2007, STUK also oversaw the monitoring programme in the ONKALO area carried out by Posiva, aimed at monitoring what safety-significant changes the construction of Onkalo may cause in the bedrock (e.g., inflow of groundwater into Onkalo, excavation damage to intact rock, materials such as concrete, introduced to Onkalo due to excavation, that are potentially harmful to long-term safety, and rock movement). The first summary report subject to review was completed in 2006.

STUK's oversight also covered bedrock research methods used by Posiva in investigations made from the surface and research carried out in ONKALO. A comprehensive report on the research methods was completed and reviewed. Other objects of oversight in 2007 included numerous other interpretations of the investigations in Olkiluoto and geological background reports, published in Posiva's report series. Bedrock research in Olkiluoto continued both from the surface and through research carried out in Onkalo.

Oversight of the development of safety analysis and the safety case

Posiva's safety case for the final disposal facility will consist of a Safety Case Portfolio containing reports and materials that are updated every few years. The portfolio covers the following main documentation items:

1. the repository site,
2. the properties of spent fuel,
3. the canister,
4. the final repository,
5. the processes (the internal and external phenomena, events and natural processes affecting the operation of the final disposal system)
6. the long-term evolution of the site and the repository,
7. the biosphere,
8. release of radionuclides (which is the actual numerical safety analysis),
9. complementary safety analyses (e.g. natural analogies)
10. summary documentation.

The review of documentation items 1–4 in 2007 has been discussed above. With regard to item 7, STUK received for review partial documentation concerning the biosphere, dealing with the concept and guidelines for numerical safety analysis, the biomass, activity, structure and functional variation of the microbe population at various sites in Olkiluoto, biosphere modelling, environmental monitoring, including its results, and types of vegetation, including the main processes affecting them. With regard to items 5, 6 and 8, the reviews will be conducted during 2008.

Other safety research

Posiva's safety research is also based on long-term bilateral and multilateral collaboration projects. The majority of the bilateral research projects are included in the collaboration between Posiva and the Swedish SKB. The most significant multilateral research projects are the integrated projects NF-PRO, FUNMIG, PAMINA and THERESA within the EU's sixth framework programme, in which Posiva and Finnish research institutes participate.

STUK considered Posiva's research collaboration in 2007 to be sufficiently extensive and of a sufficiently high standard. The collaboration with the Swedish SKB was particularly extensive. In addition to technical and scientific benefits, international collaboration helped to increase openness concerning Posiva's activities towards the scientific community, which STUK considers to have a significant impact by promoting safety and safety culture.

To the extent that Posiva directly employs the results of R&D conducted by others in the activities under STUK's regulatory control, STUK reviews this work in the same way as the operation and outputs of Posiva's other subcontractors. Depending on the safety significance, STUK follows the activities of the participating organisations through inspections, e.g. by participating in audits performed by Posiva.

5.1.3 Statements under the Nuclear Energy Degree

In accordance with the policy approved by the Ministry of Trade and Industry, Teollisuuden Voima Oy (TVO) and Fortum Power and Heat Oyj (FPH) must submit a comprehensive report on the situation and future plans for their research, development and design activities (TKS activities) in the field of nuclear waste management every three years. The report functions as the key reference report for the reporting referred to in sections 74–75 of the Nuclear Energy Decree. In the autumn of 2006, the utilities published the comprehensive report TKS-2006, Nuclear Waste Management of the Olkiluoto and Loviisa Power Plants, Programme for Research, Development and Technical Design for 2007–2009. STUK reviewed the report assisted by an international team of experts, and submitted its statement to the Ministry of Trade and Industry. STUK stated that the plans show significant progress since the previous period, but there are still considerable development needs in a number of areas. STUK also considered the schedule for the construction licence application to be tight. In STUK's opinion, conclusions on whether the schedule is realistic should not be made until the next TKS report is being reviewed, by which time Posiva must preliminarily deliver the safety reports required for the construction licence and, with regard to incomplete reports, submit a plan for their completion.

In September, Teollisuuden Voima Oy and Fortum Power and Heat Oyj delivered a report on future actions in the field of nuclear waste management for 2008 to the Ministry of Trade and Industry, which included a report on general plans for the next five years. According to the policy approved by the Ministry of Trade and Industry in 2002, this report, together with the R&D and technical design (TKS) programme report delivered at three-year intervals, covers the reports required under section 74 of the Nuclear Energy Decree. STUK reviewed the documents related to the utilities' waste management programme and gave a statement on them to the Ministry of Trade and Industry according to section 78 of the Nuclear Energy Decree.

STUK also reviewed the documents on the financial provision made for the costs of nuclear waste management referred to in section 90 of the Nuclear Energy Decree and submitted statements on them to the Ministry of Trade and Industry. In its statements, STUK assessed the technical plans and cost estimates on which financial provision is based.

6 Nuclear non-proliferation

Safeguards of nuclear materials constitute a requirement for peaceful uses of nuclear energy. Accordingly, Finland has in place a national system for nuclear material control, which is maintained by STUK. Provisions on the control system are laid down in section 118 of the Nuclear Energy Decree, and its purpose is to carry out the safeguards for the use of nuclear energy that are necessary for the non-proliferation of nuclear weapons. In addition, STUK's task is to attend to the control pertaining to international agreements in the field of nuclear energy signed by Finland.

International safeguards are implemented by the International Atomic Energy Agency (IAEA) and the European Commission's Directorate General for Transport and Energy, Directorates H and I (Euratom). IAEA safeguards are based on the Non-Proliferation Treaty and the Safeguards Agreement, (INFCIRC/193) signed by non-nuclear weapon EU Member States, the European Atomic Energy Agency and the IAEA, as well as the Additional Protocol of the Safeguards Agreement (INFCIRC/193/Add.8). EU safeguards are based on the Euratom Treaty and Commission Regulation EURATOM 302/2005. According to section 63 of the Nuclear Energy Act, STUK's presence is required in inspections performed by the IAEA and Euratom in Finland.

The Additional Protocol to the Nuclear Safeguards Agreement gave the IAEA more extensive rights to acquire information and carry out inspections to facilitate discovery of secret nuclear programmes. This new agreement entered into force in the EU on 30 April 2004. The Additional Protocol entitles the IAEA to gather more information on activities in the nuclear field. States must notify the IAEA of research and development projects related to the nuclear fuel cycle, manufacturing of components in the nuclear field and their export. In addition, the IAEA gathers information from open sources, operates satellites and collects environmental samples. The Additional Protocol allows the IAEA more extensive access rights to inspect nuclear sector activities. Such complementary access visits may be carried out at very brief notice.

STUK's nuclear safeguards activities apply to all nuclear commodities in Finland: supervision and accounting systems, imports, use, transport, storage, transfers, removal from use and final disposal. Nuclear commodities include nuclear materials (uranium, plutonium and thorium), certain other substances (deuterium and graphite), as well as nuclear devices, equipment and documentation; 99.8% of all nuclear materials in Finland are located in nuclear power plants. The most significant other nuclear material holder is the FiR 1 research reactor operated by VTT, the Technical Research Centre of Finland. STUK, the Laboratory of Radiochemistry at the University of Helsinki, OMG Kokkola Chemicals, the University of Jyväskylä, The Geological Survey of Finland, and some other institutions also have small amounts of nuclear materials in their possession. A few consignments of nuclear materials are annually imported into Finland and transported here. The most significant ones are imports and transports of nuclear fuel. Currently, only fresh fuel is transported in Finland.

STUK controls nuclear material holders through facility and transport inspections and document reviews. At facilities, STUK verifies that the quantity of nuclear materials and their physical location comply with the accounting records. STUK reviews the documents on the facilities' nuclear management: reports, notifications and nuclear safeguard manuals, and grants the licences required for control. In addition, STUK deals with the authori-

Table 6. Amounts of nuclear materials in Finland 31 December 2007.

Location	Natural uranium (kg)	Enriched uranium (kg)	Depleted uranium (kg)	Plutonium (kg)	Thorium (kg)
Loviisa plant	–	510 970	–	4 218	–
Olkiluoto 1	–	186 894	–	762	–
Olkiluoto 2	–	191 143	–	845	–
Olkiluoto, spent fuel storage (KPA)	–	960 786	–	7 983	–
VTT / FiR 1 research reactor	1 511	60	0.002	–	–
OMG Kokkola Chemicals	1 486	–	–	–	–
STUK	44.7	1,4	857	0.003	2.5
University of Helsinki, laboratory of radiochemistry	40.4	0,3	20	0.003	2.5
Other facililties	~0	~0	~817	~0	–

sation of international inspectors and submits to the IAEA the declarations concerning Finland and Finnish facilities required by the Additional Protocol.

The quantities of nuclear materials in Finland by facility and material category are shown in Table 6. The licences according to the Nuclear Energy Act are listed in Appendix 4.

6.1 Nuclear safeguards activities and results in 2007

Licences and approvals

In 2007, STUK granted ten import licences and one export licence for nuclear commodities to Teollisuuden Voima Oy, and three import licences and one export licence to Fortum. In addition, VTT, the Technical Research Centre of Finland, was granted licences for exporting documentation and nuclear material. STUK submitted two statements related to licence applications to the Ministry of Trade and Industry, one concerning equipment export and the other concerning import of nuclear material.

In 2007, STUK granted one transport licence for fresh nuclear fuel and approved four transport plans for such fuel. Fresh fuel was imported by Finnish nuclear power plants from Sweden, Spain and Russia.

In 2007, STUK approved the updated nuclear material manual of the Loviisa plant, a second person responsible for nuclear safeguards at the Loviisa plant, the new substitute for the manager responsible for the Department of Radiochemistry at the University of Helsinki, and the new manager responsible for the accelerator laboratory of the Department of Physics at the University of Jyväskylä.

In 2007, STUK approved nine new Euratom inspectors and 28 new IAEA inspectors to carry out inspections in Finland.

Declarations required under the Additional Protocol were submitted correctly and on time

Declarations pertaining to Finland, required under the Additional Protocol, totalled 18 in 2007, and all of them were submitted on time. STUK submitted to the IAEA annual declarations, the most significant of which are descriptions of plant sites. In addition, STUK submits to the IAEA quarterly information on exports according to the Additional Protocol. Euratom submitted to the IAEA the declarations pertaining to Finland under its responsibility.

Finnish nuclear safeguards functioned well

In 2007, STUK's safeguards activities focused on both inspections of the known licensees and initiating control of potentially undeclared operations throughout Finland, in accordance with the obligations and objectives of revised international safeguards.

The technical analysis methods applied in the control contribute to ensuring that nuclear materials and operations are in accordance with the notifications and that all operations are notified. STUK applies the methods to identify the materials and verify that the information notified by the facilities, e.g. the degree of uranium enrichment as well as fuel burn-up and the cooling period, is correct and complete. The methods employed comprise non-destructive measurements used to verify spent fuel, and environmental sampling.

All nuclear materials leave traces of their origin and treatment. The environmental samples collected in nuclear safeguards activities are used to investigate these traces in order to determine whether the nuclear operations comply with the notifications. Samples are collected as wipe samples from surfaces at sites where nuclear materials are handled.

The results of inspections carried out in 2007 show that Finnish nuclear safeguards function well. No materials or operations conflicting with the notifications were observed, and the inspected materials and operations corresponded to the notifications submitted by the facilities. In its inspections STUK made remarks to two operators in 2007, and required that they make their reports and method descriptions more specific. The IAEA and Euratom made no remarks concerning the inspections. All of the facilities operated in a way that facilitated STUK's fulfilment of the obligations of the international agreements in the nuclear field signed by Finland.

In 2007, STUK carried out a total of 27 nuclear materials inspections at nuclear power plants, including 10 at Loviisa and 17 at Olkiluoto. Of these, Euratom participated in 20 and the IAEA in 21 inspections. In 2007, STUK verified by non-destructive methods 227 spent fuel assemblies and two hermetic bottles used for storing fuel rods at the Olkiluoto power plant, and 253 spent fuel assemblies at the Loviisa power plant.

During the year, STUK collected two wipe samples and sent six samples collected in 2006 for analysis.

In addition, STUK inspected the transport of fresh fuel to Loviisa in 2007.

STUK, the IAEA and Euratom carried out one joint inspection of a nuclear material inventory for the FiR 1 research reactor operated by VTT, in connection with which STUK made a remark to VTT concerning deficiencies in VTT's accounting and reporting system. In a follow-up inspection, STUK found them to be appropriately corrected. STUK reviewed an update of VTT's nuclear safeguard manual. In 2007, STUK, the IAEA and Euratom carried out inspections at STUK's premises, the Laboratory of Radiochemistry at the University of Helsinki and OMG Kokkola Chemicals, and complementary audits according to the Additional Protocol at the University of Jyväskylä on 6 June 2007 and at Metso's premises in Tampere on 27 September 2007.

Nuclear safeguards at Onkalo

STUK has obliged Posiva Oy, which is examining final disposal and its implementation, to ensure the implementation of nuclear safeguards during the construction of Onkalo, as the underground research facility (Onkalo) is designed to become part of a final disposal facility. The aim of the obligation is to ensure that all necessary information on the final disposal facility will be available in due course, and that it will be possible to show that no undeclared operations relevant to nuclear safeguards exist in the final repository area. Another aim is to ensure that the IAEA can be assured of Finland's capability to implement adequate safeguards and plan cost-efficient future control and inspection procedures. The final disposal of nuclear fuel in an underground repository presents new challenges for safeguards planning and implementation since, after encapsulation, nuclear material verification will be impossible in practice.

In 2007, STUK carried out four nuclear non-proliferation inspections on the Onkalo construction site to ascertain that the underground facilities correspond to the notifications. Three of these were normal periodic inspections and one was organised for the IAEA's and Euratom's technical visit in order to familiarise these organisation's representatives with the nuclear non-proliferation controls implemented by Posiva and STUK. STUK also inspected Posiva's nuclear non-proliferation system in 2007, and prompted Posiva to update the non-proliferation procedures in its nuclear non-proliferation manual. The IAEA participated as an observer in a total of three inspections of Onkalo in 2007, and Euratom in two.

STUK and Posiva provided the European Union's JRC Ispra with an opportunity to scan the underground premises with a digital laser scanner. The results were compared with Posiva's own measurements, which provided STUK with an independent verification of the excavated premises. STUK submitted a summary of the regulation of the construction of the underground research facilities to the IAEA and Euratom on 23 April 2007, and submitted a notification concerning the project as required by the Additional Protocol.

STUK controlled transfers of nuclear products

In order to prevent proliferation of nuclear weapons and sensitive nuclear technology, STUK controlled transfers of nuclear products and provided expert assistance to the customs authorities, the police and other authorities in 2007. A licence granted by either STUK or the Ministry of Trade and Industry is required for imports and exports of nuclear products. STUK's licence and a transport plan approved by STUK are required for the transport of nuclear materials. STUK participated in border control by providing expert assistance to the customs authorities in terms of the action required for abnormal events detected by radiation monitors and the development of radiation control at the borders, such as equipment acquisitions.

One of the abnormal radiation detections in border control in 2007 was related to nuclear materials. A piece of depleted uranium was transported to Finland within a load of scrap metal. The uranium was delivered to STUK and included in nuclear material accounting.

6.2 The Comprehensive Nuclear Test Ban Treaty

The Comprehensive Nuclear Test Ban Treaty (CTBT) prohibits all nuclear testing. The Treaty was opened for signing in 1996. It will enter into force after ratification by 44 separately designated states. Finland ratified it in 1999. Adherence to the Treaty is monitored by means of an international monitoring system (IMS), which, when complete, will comprise 321 monitoring stations. Of these, 80 stations detect radioactive particles in the atmosphere and 40 are also capable of detecting radioactive xenon gas. The measurement results of the monitoring stations are available to all Member States.

A special Preparatory Commission, which convenes in Vienna, is preparing for the Treaty's entry into force. All signatory states are represented in the Commission. The Provisional Technical Secretariat, whose tasks include constructing and maintaining the international monitoring system, operates in Vienna as well.

STUK contributed to the work of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) in establishing a cost-effective organisation that is functional from the Finnish perspective. The automatic analysis software used for the STUK's routine monitoring of IMS data analysed on average about 600 gamma spectra per day in 2007, which represents an increase of almost 20% compared with the previous year. The increasing number of analyses is due to the fact that new stations are still being constructed for the CTBTO's network of monitoring stations. Routine monitoring is facilitated by an alarm system transmitting data on unusual observations to STUK personnel. No abnormal activity levels relevant to the Treaty were observed in 2007.

In 2007, STUK also developed the software necessary for analysing xenon gas measurements. The CTBTO's xenon gas monitoring station network is developing rapidly, and it was possible to confirm the North Korean nuclear test carried out in 2006 based on xenon gas measurements.

STUK received notifications of abnormal seismic events in the Kola peninsula area, sent by the Institute of Seismology on 20 August 2007 and 29 October 2007. STUK participated in investigations of both cases. Neither of them indicated a nuclear explosion.

7 Safety research

The purpose of safety research is to ascertain that the authorities have adequate expertise available, also concerning unforeseeable issues affecting the safety of nuclear facilities. Publicly-funded safety research is divided into two research programmes, of which SAFIR2010 focuses on nuclear power plant safety and KYT2010 on strategic analyses of nuclear waste management. The projects under the research programmes are selected annually on the basis of a public call for projects. The projects selected for the programmes must be of a high scientific standard and their results must be available for publication. The results must have a broader scope of applicability than the nuclear facility of a particular licensee. STUK controls this research by contributing to the work of the programmes' steering and reference groups. The Ministry of Trade and Industry ascertains that the proposed group of projects for each year meet the statutory requirements and STUK's research needs related to nuclear safety. STUK issued its statement on the projects under the publicly-funded SAFIR2010 research programme for 2007 in January, and a corresponding statement on the KYT2010 programme in February.

The final seminar of the predecessor of SAFIR 2010, the four-year SAFIR research programme, was held in January. The new four-year SAFIR2010 programme, similar to the previous one, was launched at the same time. The core areas of the new programme are fuel and reactor physics, structural safety of the reactor circuit, thermal hydraulics and accident analyses. A slightly lesser input is directed at organisations and human factors, automation and control room, and the employment of probabilistic risk analysis in safety management and control. As a new feature, construction safety is a separate area of research under the programme. The funding of the SAFIR2010 research programme totalled €6.3 million in 2007, which represents about half of the nuclear facility safety research in Finland. The research programme pro-

Nuclear safety research in Finland

In Finland, nuclear safety research is conducted by research institutions, universities and utilities operating nuclear power plants. In general terms, nuclear safety research comprises two distinct areas of research: nuclear power plant safety and nuclear waste management.

Public research programmes related to nuclear safety currently operational in Finland are the nuclear power plant safety research programme SAFIR2010 (2007–2010) and the national nuclear waste management research programme KYT2010 (2006–2010).

The purpose of these programmes is not only to provide scientific and technical results, but also to ensure the maintenance and development of Finnish expertise. The Ministry of Employment and the Economy provides information on the projects on its website at www.tem.fi.

Finnish actors contribute extensively to international nuclear safety research within the framework of the following programmes and organisations: the European Union's framework research programmes (both fission and fusion research), the Nordic safety research programme NKS, the Nuclear Energy Agency (NEA) of the OECD, and the International Atomic Energy Agency (IAEA) within the UN family.

Finnish actors have also preliminarily charted issues related to the technology, safety and economy of new-generation GEN4 reactors. GEN4 research is financed within the four-year Sustainable Energy (SusEn) research programme of the Academy of Finland, launched at the beginning of 2008. Research into generation IV reactors is part of energy technology research.

** The Ministry of Trade and Industry became the Ministry of Employment and the Economy at the beginning of 2008.*

vided funding to 30 research projects in various areas of research. The areas of research under SAFIR2010 and their shares of the total funding are shown in Figure 12.

The safety research programme supports safe operation of the existing nuclear power plants, and also prepares for new plants. The expertise generated within the research programme has been utilised in the review and assessment carried out in 2007 related to the extension of the operating licences for the Loviisa nuclear power plants and when assessing the safety of the new plant under construction. Experts, calculating methods and test equipment have been employed in terms of issues related to ageing management and the review of accident analyses, and, with regard to the new plant, to assess the quality and manufacturing methods of reactor circuit piping, estimate the fire resistance of cables and ensure that requirements for aircraft impact are met.

Twenty applications were received for the KYT programme for 2007, 18 of which were accepted. Thirteen of them continued the work carried out the previous year. The total volume of the programme in 2007 was €1.2 million, and it was divided into four main areas: strategic analyses (3 projects), technical barriers (5), the bedrock and groundwater (4), and the release and migration of radionuclides (6). Figure 13 shows the relative shares of these areas of the total funding.

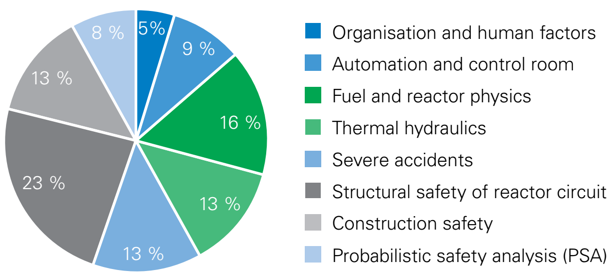


Figure 12. Distribution of the costs of research and commissioned work pertaining to the safety of nuclear power plants.

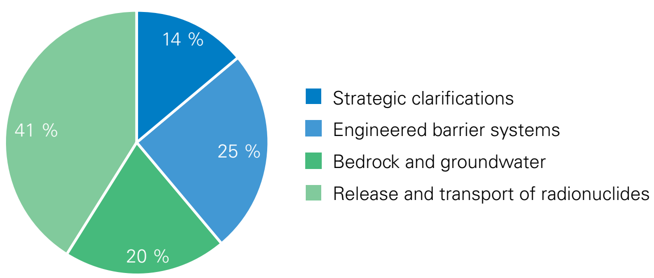


Figure 13. Distribution of the costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

8 Nuclear facilities regulation and development of regulation

8.1 Processes and structures

8.1.1 Document review

A total of 3,770 documents were submitted to STUK for review in 2007. Of these, 1,969 concerned the nuclear power plant under construction, and 62 were related to the final disposal of spent nuclear fuel. Document reviews totalling 3,447 were completed, including documents submitted in 2007, those submitted earlier and licences granted by STUK in accordance with the Nuclear Energy Act, which are listed in Appendix 4. The average document review time was 71 days. The number of documents and their average review times in 2003-2007 are shown in Figure 14. Figures 15, 16 and 17 present the distribution of document review times for the different plant units.

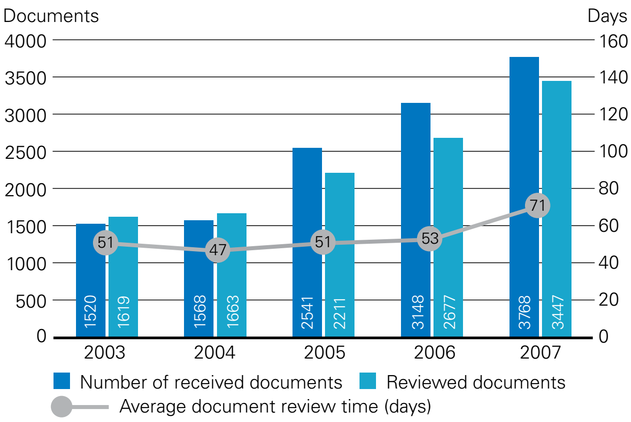


Figure 14. Number of documents received and reviewed as well as average document review time.

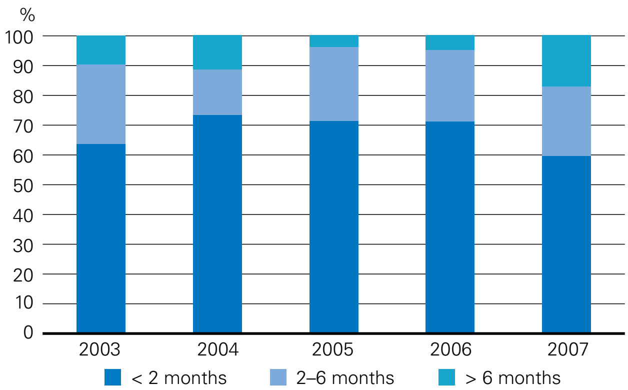


Figure 15. Distribution of time spent on preparing decisions on the Loviisa plant .

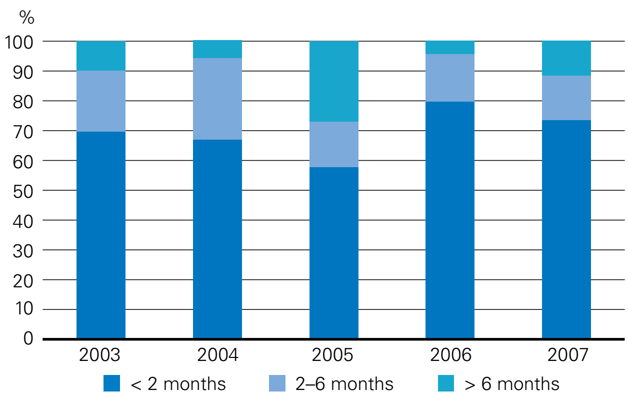


Figure 16. Distribution of time spent on preparing decisions on Olkiluoto plant units 1 and 2.

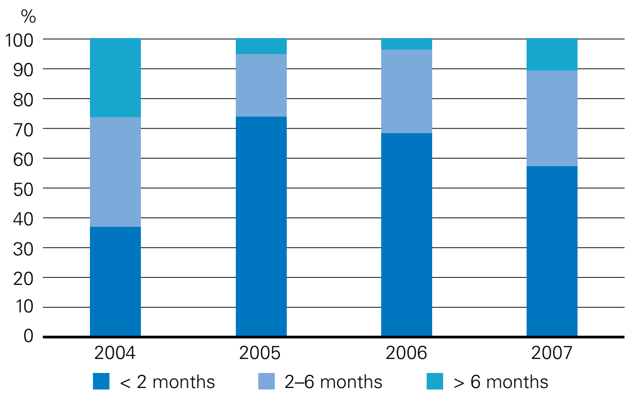


Figure 17. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

8.1.2 Inspections on site and at suppliers' premises

Periodic inspection programmes

The 2007 periodic inspection programme (Appendix 5) was planned to include 23 inspections at the Loviisa plant and 20 at the Olkiluoto plant. During the year, it was found that STUK did not have the resources to carry out all of the inspections and, accordingly, it was decided to omit four inspections at the Loviisa plant and five at the Olkiluoto plant. In addition, a total of four inspections were postponed to the beginning of 2008 due to co-ordination of schedules. Two additional inspections were carried out at the Olkiluoto plant, concerning the implementation of organisational changes and the personnel resources of the reactor physics office. The observations are presented in the chapters on regulation.

In 2007, STUK carried out 11 inspections of the Olkiluoto 3 construction inspection programme (Appendix 6). In addition, STUK assessed construction site supervision within the construction project in a separate inspection. The fire safety as well as the physical protection and emergency preparedness of the plant unit under construction were assessed in connection with the periodic inspections of the operating Olkiluoto plant units.

Inspection programme during the construction of Onkalo

In 2007, STUK carried out six inspections according to the inspection programme during the construction of the underground rock characterisation facility (Onkalo), comprising a total of 20 person-days. One inspection was postponed to 2008. In addition, STUK carried out 12 technical construction site inspections and participated in nine follow-up meetings between Posiva and STUK. These figures exclude the four safeguards inspections mentioned in Chapter 6.

Other inspections on plant sites

A total of 937 inspections on site or at suppliers' premises were carried out in 2007 (other than inspections of the periodic or construction inspection programmes, of the safeguards of nuclear materials and of the construction inspection programme of the underground rock characterisation facility at Olkiluoto, which are discussed separately). An inspection comprises one or more partial inspections, such as a review of results documentation, an inspection of a component or a structure, a pressure or leakage test, a functional test or a commissioning inspection. Of the inspections, 433 pertained to oversight of the plant under construction and 540 to that of the operating plants. Relevant documents are reviewed prior to on-site inspection.

The number of inspection days on site and at component manufacturers' premises totalled 2,321. This number includes not only inspections pertaining to the safety of nuclear power plants but also those associated with nuclear waste management and safeguards and audits and inspection of the underground rock characterisation facility at Olkiluoto. In addition, a total of 199 inspection days outside normal working hours were spent at operating nuclear power plants, mostly during annual maintenance outages, as well as 58 inspection days at the plant under construction. The number of days spent on inspection has increased due to the inspections relating to the construction of the new nuclear power plant. Four resident inspectors worked at the Olkiluoto nuclear power plant. The Loviisa plant has one resident inspector. The number of on-site inspection days in 2003–2007 is shown in Figure 18.

8.1.3 STUK's own development projects

The development of STUK's own operation focused on completing the definition of nuclear safety-related processes and the revision of the quality manual. The review of processes related to nuclear waste regulation was launched in 2007, and a plan was drawn up for the revision of the guidelines concerning safeguards of nuclear materials and

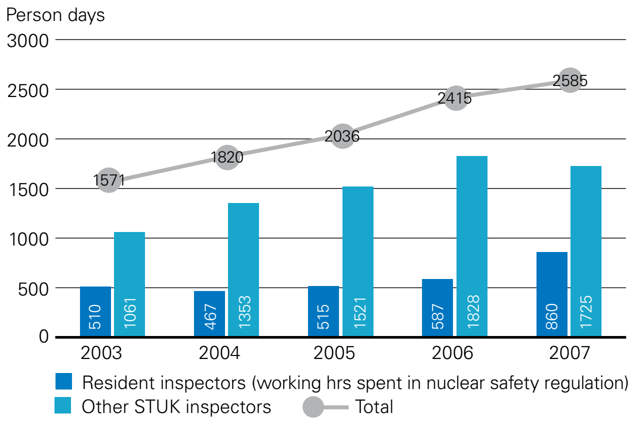


Figure 18. Number of inspection days onsite and at component manufacturers' premises.

nuclear waste management. Two new guidelines were approved, dealing with the regulation of the final disposal project for spent nuclear fuel generally, as well as the construction of Onkalo and the construction inspection programme. The overall aim is to update all of the old guidelines and to draw up seven new ones. One new guideline related to safeguards of nuclear materials and two other guidelines were updated. The new guideline deals with the nuclear safeguards required under the IAEA Additional Protocol.

On the basis of feedback acquired from the utilities, inspection consistency was improved. As one means for increasing consistency, the contents of the inspection programmes were revised. The regulatory practices for the oversight of organisations were modified once its resources were increased.

In 2007, KPMG carried out a review of the internal audit of the nuclear power plant regulation process. Alongside KPMG's review, two external experts conducted their own review of the nuclear power plant regulation process, supplementing KPMG's review. The purpose of KPMG's review was to assess the functionality of an internal audit of the key processes of nuclear power plant regulation. The processes reviewed were the licence procedure, drawing up of guidelines, periodic inspections of operation and construction and the department's decision-making process. As a positive observation, KPMG highlighted the motivation and professional skill of the personnel, among other things. A total of nine observations were made in the review, based on which KPMG made recommendations. Two of the observations were classified as prominent and the others as important. The prominent observations were related to the identification and management of risks and resource management. Based on the recommendations given, it was agreed to implement development actions in 2008. The observations of the external experts were very similar to those of KPMG.

Interactive groups improve the efficiency of the nuclear waste office

The work of the nuclear waste management office was reorganised at the beginning of 2007. Posiva Oy's final disposal project for spent nuclear fuel is a demanding subject for regulatory control, as the project includes many items implemented for the first time in the world. Posiva's organisation and the safety documentation produced by it have expanded rapidly over the past few years, and the schedule in view of the construction license application expected at the end of 2012 is tight. At the same time, the construction of the underground rock characterisation facility, Onkalo, is progressing towards the final disposal depth, which is important for safety.

These underlying factors resulted in hiring new experts and changing the organisation of the nuclear waste management office. In terms of the regulation of the final disposal project, experts in various fields of technology and science must collaborate seamlessly. Five groups according to duty/expertise areas were formed in the office:

- Final disposal technology, the main task of which is to assess whether the technical barrier system (fuel matrix, waste canister, bentonite buffer, and backfill and sealing structures) can be constructed according to the design bases and whether it preserves its long-term performance.
- Final repository, the main task of which is to assess and control whether the bedrock conditions at the final disposal depth conform with the design bases and whether they will continue to do so in view of the construction of the final disposal facility and the impact of long-term climate changes.
- Safety assessment, the main task of which is to assess the safety case for final disposal to determine whether safety is ensured to a sufficient degree of certainty, how the uncertainties are managed and what are the most essential needs for further research.
- Regulation of operation, the main task of which is to oversee the waste management of operating nuclear power plants and its implementation.
- Regulation of construction, the main task of which is to oversee the design, extensions, construction and commissioning of all nuclear waste facilities. ONKALO is the most important nuclear waste facility under construction. Regulation of construction is usually implemented as a project.

The groups have leaders and office personnel belong to more than one group. According to the experiences so far, the new organisational model has increased self-direction, improved sharing of knowledge and increased co-operation and the efficiency of the work of the office.

The internal working group on security issues increases co-operation within STUK

An internal working group was established at STUK in 2007 to ensure that STUK's operations to prevent illegal activities related to nuclear materials or radioactive substances are as efficient as possible. The purpose of the working group on security issues is to enhance co-operation within STUK, prepare guidelines and agree on the division of labour between the different units. In addition, the group aims to contribute to ensuring that operators have in place appropriate physical protection of nuclear materials and radiation sources.

Control of the transport of nuclear materials and other radioactive substances was assigned to two people, one of whom focuses on transport in the nuclear field and the other on transport of other radioactive substances.

STUK's own international operational experience feedback activities are being developed

STUK's own international operational experience feedback activities were reorganised and their procedures were developed to improve the efficiency of operations at the international level and to support development ideas concerning the activities. Co-ordination and maintenance was transferred to the management support functions of the Department of Nuclear Reactor Regulation, where they come under the responsibility of the Deputy Director of Nuclear Reactor Regulation. The international operational experience feedback team ("the IRS team"), which includes representatives of all the expert offices of Nuclear Reactor Regulation, designated in 2007, reviewed IRS-reported events received via the IAEA and the lessons based on them from the viewpoint of Finnish nuclear power plants. The results of the review, including its justifications, were recorded in STUK's IRS database, which was developed to better correspond to STUK's needs. The actions taken regarding each IRS report were systematically recorded in the database, and a field for an English-language feedback report was added to the database. Such a report is drawn up for events for which it has been decided to require Finnish plants to take action or for which a good Finnish practice has been found. The utilisation of the summary reports (Topical Reports, Blue Books) jointly published by the IAEA and the NEA on the basis of IRS reports also takes place via the IRS team.

The indicator data system is being developed in parallel with its utilisation

Since the beginning of 2006, an INDI data system has been used in the maintenance and reporting of the indicators used for nuclear facilities regulation. The system has been developed in parallel with its utilisation. In 2007, quarterly and annual report templates were created, and the original English software was translated into Finnish.

New indicators concerning fuel integrity and the accident risk of nuclear power plants were defined in the system. Software user rights were extended, an operating manual was compiled and training was organised for new users.

A licentiate thesis related to the topic was completed at STUK, and the methods developed in its theoretical section and tested were employed to analyse STUK's safety performance indicators. The results can be utilised in indicator trend analyses in the future.

Development of records management

The project to develop a comprehensive records management solution for STUK, spanning several years, was continued. The aim is that the RM (Records Management) system supplied by Affecto-Genimap Oy will in the future replace STUK's current separate records systems and registers. The new system also makes possible internal digital records management (workflow) at STUK. The system preliminarily provides for electronic services to external clients. Introducing the records management solution also requires that STUK's registry establishment plan (AMS) is reviewed and updated.

Electronic inspection protocols

The Department of Nuclear Reactor Regulation currently uses more than ten different inspection protocol forms. The manual procedures for these protocols in their current format do not allow optimal information management. During the year, the needs for developing each individual protocol form were analysed together with the inspectors drawing up the protocols. The requirement specification for the electronic system to be developed was almost completed. Modelling the process of using several different protocols that are completed at several phases in an electronic system has proven to be a more challenging development project than anticipated, and it has been necessary to assess the suitability and usability of different technical implementation options as part of the requirement specification. The project will proceed to the competitive tendering phase in 2008.

8.2 Renewal and human resources

Training was organised for inspectors concerning nuclear power plant systems and regulatory operations, for example. Ten new STUK inspectors participated in the fourth national training programme in the nuclear field (the YK course), which STUK organises together with other actors in the field. The duration of the fourth YK course was five weeks, three of which were held in the spring of 2007. The YK5 course was launched in the autumn of 2007, where nine STUK inspectors participated among a total number of 50 participants. The entire YK course concept was reviewed in 2007. The recommendations of the review report were considered in the planning of the YK5 course; the course programme was made more compact and it was agreed that new training material will be delivered in its entirety in Finnish.

STUK's inspectors also participated in training provided by external enterprises, such as the lead auditor training organised by Excellence Finland, and various domestic and international training events. In addition, supervisors in the nuclear safety field participated in leadership skills coaching programmes.

One inspector participated in the "Nuclear Safeguards and Non-Proliferation" course organised by the European Safeguards Research and Development Association (ESARDA), and another in the "Training Workshop for Net-Enabled Waste Management Database" training event organised by the IAEA.

Two STUK inspectors completed a doctor's degree, and both theses were related to nuclear waste management. The first thesis investigated the post-Ice Age seismic history of Olkiluoto and the surrounding sea by means of ice formation simulations, acoustic-seismic sounding of the sea bottom and sediment research. The second thesis dealt with the thermal mechanics of porous substances using computational methods. The paper explored coupled modelling of the behaviour of one technical barrier included in the geological final disposal plans for high-level nuclear waste, namely buffer material fabricated from swelling clay.

On average, 10.8 days per inspector in the field of nuclear waste and materials regulation and 6.1 days per inspector in the field of nuclear reactor regulation were spent on developing the expertise of STUK's nuclear safety experts in 2007.

Seven new inspectors were hired for nuclear reactor regulation in 2007. Two of them were employed in the oversight of organisational operation and management, two in the field of I&C technology, two in inspections of mechanical components, and one in oversight of the radiation safety of nuclear power plants. Five new inspectors were recruited in nuclear waste management regulation, whose areas of responsibility include oversight of low- and intermediate-level waste, the encapsulation technology related to the final disposal of spent fuel, biosphere analyses, chemistry issues and bentonite and other backfilling materials.

8.3 Finances and resources

The duty area of nuclear safety regulation included basic operations subject to, and not subject to, a charge. Basic operations subject to a charge mostly consisted of the regulatory control of nuclear facilities, with their costs charged to those subject to control. Those basic operations not subject to a charge included international and domestic co-operation as well as emergency response and communications. Basic operations not subject to a charge are publicly funded. Overheads from rule-making and support functions (administration, development projects in support of regulatory activities, training, maintenance and development of expertise, reporting as well as participation in nuclear safety research) were carried forward into the costs of both types of basic operation and of contracted services in relation to the number of working hours spent on each function.

In 2007, the costs of the regulatory control of nuclear safety subject to a charge were €12.0 million. The total costs of nuclear safety regulation were €13.2 million. Thus the share of activities subject to a charge was 90.9%.

The income from nuclear safety regulation in 2007 was €12.0 million. Of this, €2.1 million and €8.4 million came from the inspection and review of Loviisa and Olkiluoto nuclear power plants, respectively. In addition to the operating plant units, the income from the Olkiluoto plant includes regulatory control of the new plant unit. The income from the inspection and review of Posiva Oy's operations was €1.4 million. Figure 19 shows the annual income and costs from nuclear safety regulation in 2003–2007.

The time spent on the inspection and review of the Loviisa nuclear power plant was 11.1 person-years, i.e. 9.9% of the total working time of the nuclear regulatory personnel. For Olkiluoto nuclear power plant's operating units it was 9.8 person-years, which accounts for 8.6% of the total working time. In addition to the oversight of the operation of nuclear power plants, the figure includes nuclear material control. The time spent on inspection and review of Olkiluoto 3 was 29.1 person-years, i.e. 25.6% of the total working time. The time spent on nuclear waste management inspection and review was 5.7 person-years and that spent on the FiR 1 research reactor was 0.06 person-years. The working time spent on small-scale users of nuclear material was 0.02 person-years.

Where necessary, STUK commissions independent safety analyses and research in support of regulatory decision making. Figures 20 and 21 show the costs of nuclear safety research in 2003–2007. In addition to technical support projects, the pre-2005

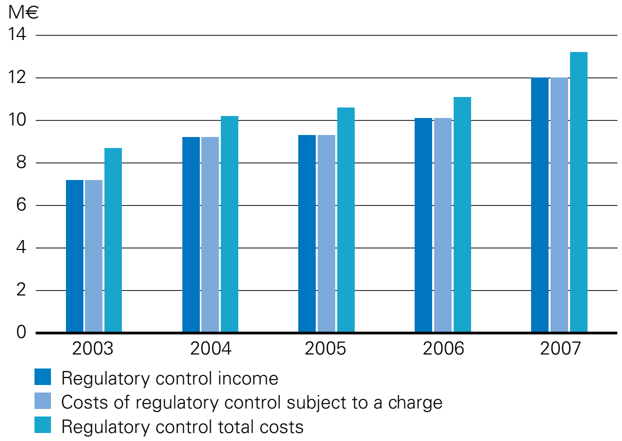


Figure 19. Income and costs of nuclear safety regulation.

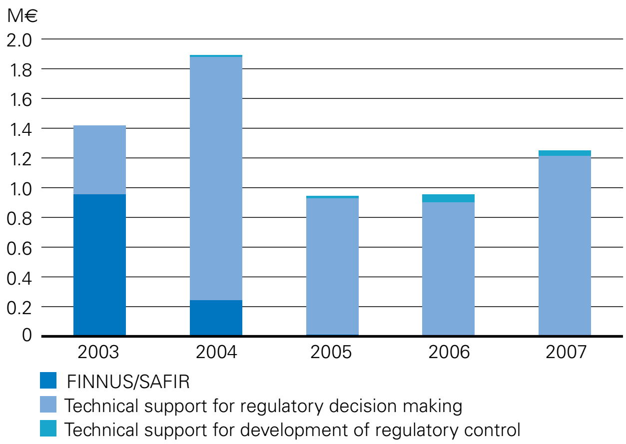


Figure 20. The costs of research and commissioned work pertaining to the safety of nuclear power plants.

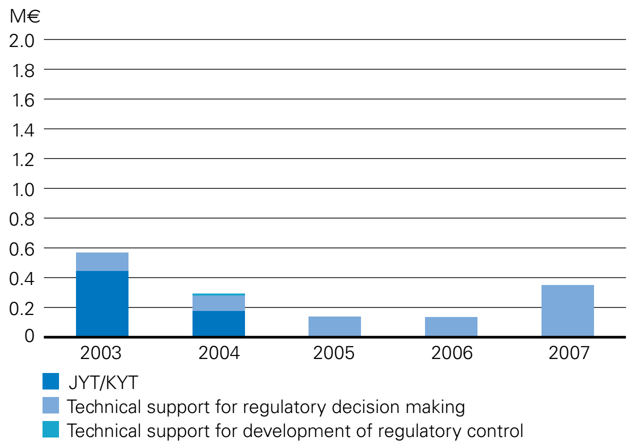


Figure 21. The costs of research and commissioned work pertaining to nuclear waste management and nuclear non-proliferation.

Table 7. Distribution of working hours (person-years) of the regulatory personnel in each duty area.

Duty area	2003	2004	2005	2006	2007
Basic operations subject to a charge	29.2	44.7	47.1	53.6	55.7
Basic operations not subject to a charge	6.4	5.1	7.2	5.7	6.1
Contracted services	4.9	5.1	3.3	3.0	2.2
Rule-making and support functions	28.2	22.7	27.5	28.8	30.3
Holidays and absences	15.9	16.9	16.9	20.0	19.1
Total	84.6	94.5	101.9	111.0	113.4

figures also reflect the costs of national nuclear safety research. The costs for 2007 mostly relate to reference analyses and independent assessments made for the plant unit under construction. Appendix 7 lists STUK-financed technical support projects completed in 2007.

The distribution of the annual working time of the nuclear regulatory personnel to duty areas is shown in Table 7. Figure 22 presents the distribution of working time spent on main functions in 2003–2007.

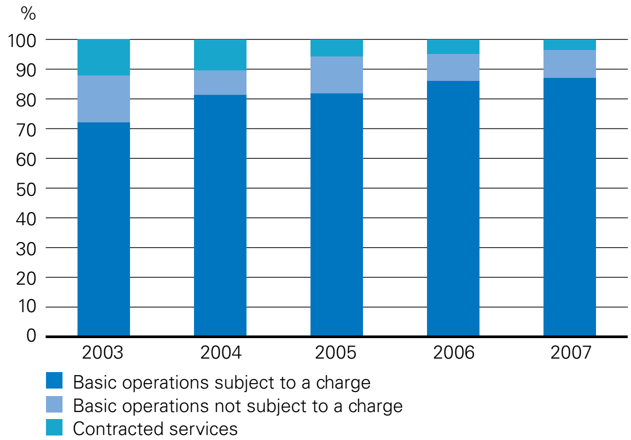


Figure 22. Working time spent on main functions.

9 Emergency preparedness

Several emergency response training events and exercises were organised at STUK in 2007. The exercises test the operation of the emergency response organisation, the functionality of the emergency response guidelines and the usability of the emergency response premises in practice, and develop these on the basis of the feedback received from the exercises. In addition, they familiarise new personnel with STUK's operations in emergency situations and their personal duties in the emergency response organisation.

In 2007, two emergency exercises concerning nuclear power plants were organised on the plant sites in Finland. The Loviisa plant exercise was organised on 23 November 2007 and that in Olkiluoto on 28 November 2007. The exercises were less extensive in terms of the number of participants than the rescue operation exercises organised every three years. The exercise participants were the utility concerned and STUK; in the case of the Olkiluoto exercise, Rauma rescue services also participated with small-scale manning. In both cases, STUK participants numbered about 50, some of whom were undergoing training. The aim was to test the initiation of activities, co-operation between the authorities and the utility, assessment of accident situations and dissemination of information to the public and the media.

Both nuclear power plants also organise fire training and drills, with the fire brigades of the plants and the fire and rescue services of the surrounding municipalities participating. At Olkiluoto, drills were organised on the Olkiluoto 3 construction site on 18 June 2007 and on 26 November 2007, and at the operating power plants on 19 November 2007. Senior officers of the Loviisa power plant's fire brigade participated in the KESI exercise on co-operation with the authorities on 24 October 2007, and an exercise in combating chemical spills was organised at the plant on 14 May 2007.

STUK also participates in international emergency exercises concerning nuclear power plants. In 2007, an emergency exercise was organised at the Leningrad nuclear power plant on 19–20 September 2007, where 15 STUK personnel participated. One of them followed the operation of Rosenergoatom's emergency response organisation in Moscow and one that of the Leningrad nuclear power plant. The main objective was to test assessment of accident situations and maintenance of the assessment, as well as dissemination of information between Russia and Finland. During the exercise, STUK received messages and posed additional questions to the Russian participants.

10 Communication

STUK informed about power plant malfunctions and furthered understanding of nuclear power and safety in local communities

In 2007, STUK issued five press releases on nuclear safety issues. Two of these were related to quality deviations at the Olkiluoto nuclear power plant under construction. In June, STUK provided information about a fire in the turbine building at the Olkiluoto 2 nuclear power plant unit. In September, STUK issued two press releases about the operational disturbance leading to a scram at the Olkiluoto 2 power plant unit and its investigation.

During the year, STUK's experts answered questions posed by domestic and international media, in particular, questions concerning the Olkiluoto 3 plant unit.

Fennovoima Oy's nuclear power plant plans created a lot of interest from journalists.

Towards the end of the year, STUK's experts also toured and gave talks on nuclear and radiation safety in localities involved in Fennovoima's plans. STUK representatives participated in public events organised by the municipalities in Pyhäjoki and Kristiinankaupunki. The debate and visits will continue in 2008.

11 International co-operation

11.1 International conventions

The Convention on Nuclear Safety requires the submission of a report on how its obligations have been met every three years. STUK was responsible for the Finnish national report, which was submitted to the IAEA, functioning as the Convention's secretariat, according to the agreed schedule in the autumn of 2007. Corresponding reports have previously been submitted in 1999, 2002 and 2004. This latest report will be reviewed by the Contracting Parties in an extensive international conference in Vienna in the spring of 2008.

11.2 Co-operation in international organisations and bilateral co-operation

Co-operation with the IAEA

The Director General of STUK acts as the Vice Chairman of the International Nuclear Safety Advisory Group (INSAG), which provides information and advice on nuclear safety issues to the Director General of the IAEA and gives recommendations for safety improvements in the IAEA member countries. In 2007 the INSAG worked on a new

Table 8. IAEA safety standard committees in which STUK's representantives participated.

Regulatory committee	Subject
NUSSC, Nuclear Safety Standards Committee	nuclear safety
WASSC, Waste Safety Standards Committee	safety of the nuclear waste management
TRANSSC, Transport Safety Standards Committee	safety of transport of radioactive material
RASSC, Radiation Safety Standards Committee	radiation safety

Table 9. STUK acts as Finland's liaison organisation for the below information exchange systems maintained by the IAEA.

Information exchange system	Subject
IRS, Incident Reporting System	events at nuclear power plants
IRSRR, Incident Reporting System for Research Reactors	events of research reactors
INES, International Nuclear Event Scale	classification of international nuclear events in terms of safety significance
PRIS, Power Reactor Information System	nuclear reactors in electricity production
NFCIS, Nuclear Fuel Cycle Information System	nucler fuel cycle
NEWMDB, Net enabled Waste Management Database	nuclear waste
DRCS, Directory for Radioactively Contaminated Sites	radioactively contaminated sites
ITDB, Illicit Trafficking Database	illicit trafficking involving nuclear and other radioactive material
EVTRAM, Events that have arisen during the Transport of Radioactive Material	transport of radioactive material
DIRATA, Discharges of Radionuclides to the Atmospheric and Aquatic Environment	radioactive releases into the environment

Table 10. STUK was represented in all of the OECD's main committees dealing with radiation and nuclear safety. STUK also participated the activities of the working groups of the main committees.

Subjects of the main committees	Working groups
Safety research CSNI, Committee on the Safety of Nuclear Installations STUK's representative as a member of the steering CSNI Bureau	• GAMA, Working Group on Accident and Analysis • WGRISK, Working Group on Risk Assessment • WGHOF, Working Group on Human and Organisational Factors • WGFS, Working Group on Fuel Safety
Regulation of nuclear safety CNRA, Committee on Nuclear Regulatory Activities The Director General of STUK acted as the chairman of CNRA in 1998–2007. Since the meeting of June 2007 he was a member of the steering CNRA Bureau.	• WGIP, Working Group on Inspection Practices • WGOE, Working Group on Operating Experience • WGPC, Working Group on Public Communication of Nuclear Regulatory Organisations
Radiation safety CRPPH, Committee on Radiation Protection and Public Health	• WPNEM, Working Party on Nuclear Emergency Matters • EGOE, Expert Group on Occupational Exposure • EGBAT, Expert Group on Best Available Technologies
Nuclear waste management RWMC, Radioactive Waste Management Committee	• IGSC, Integration Group for the Safety Case

report, "Improving the International Operating Experience Feedback (OEF) System".

STUK's representative is also included in another group invited by the Director General, the SAGSI dealing with nuclear material safeguards.

The IRS national co-ordinator designated by STUK changed. Co-ordinator rights were also applied for from the IAEA for a second STUK representative. Revision of the IRS Reporting Guidelines was started by the IAEA, involving the active contributions of STUK's IRS co-ordinators, who participated in the first meeting of the group looking into the revision in August 2007. STUK made a motion to grant IRS rights to four employees of the Institute for Energy, Joint Research Centre, IE-JRC Petten at the meeting of IRS co-ordinators. The justification for the motion was that STUK would use the research centre in Petten as a technical support organisation for drawing up and reviewing IRS reports. The rights were granted at the beginning of 2008.

STUK's representative has acted as the chairman of the IAEA Nuclear Safety Committee (NUSSC) for two terms. The terms of all of the committees expired at the end of 2007.

STUK's representatives took part in the IAEA's expert groups that review national nuclear safety regulation in Japan and Australia (International Regulatory Review Service, IRRS).

Co-operation with the OECD/NEA

At its meeting in December 2006 the CNRA decided to establish a WGOE Task Group, "Use of Operating Experience Feedback for Improving Nuclear Safety (IOEF)". STUK designated its representative to the Task Group, which assessed the strengths and weaknesses of the current international operational experience feedback processes and networks. The Task Group convened three times in 2007: in January, April and October. It drew up a report on its evaluation giving recommendations for enhancement of practices, and sub-

Table 11. OECD/NEA topical databases and data base projects for which STUK has nominated representatives.

Database	Subject
ICDE, International Common-Cause Failure Data Exchange,	CCFs
FIRE, Fire Data Exchange	fires
OPDE, Piping Failure Data Exchange	piping failures
IAGE, Integrity of Components and Structures	structural integrity
*ISOE, Information System on Occupational Exposure	occupational radiation doses
COMPSIS, Exchange of Operating Experience Concerning Computer-based Systems Important to Safety	faults of programmable systems and equipment
SCAP, Stress Corrosion Cracking and Cable Ageing	stress corrosion and cable ageing

* co-sponsored by the IAEA

mitted it to the December meeting of the CNRA for approval.

Each CSNI working group holds at least one general meeting each year and the necessary topical meetings, in which STUK's representatives participated in 2007. The WGHOF organised a seminar in Chester in the spring of 2007 on the assessment of licensees' safety culture and the related regulatory inspections. The WGIP's representative was also invited to take part in the workshop.

Co-operation with the EU

The Director General of STUK submitted an initiative to the Western European Nuclear Regulators' Association (WENRA) to establish a clearinghouse for operational experience feedback on nuclear power plant events in Petten, the Netherlands, for example, in conjunction with the EU Joint Research Centre. During the year, STUK has actively presented concrete proposals concerning the organisation and content of this operation in various connections (WENRA, INSAG, WGOE). A project co-ordination meeting was held in Brussels towards the end of July. Representatives of regulatory authorities, technical support organisations, JRC-Petten, the IAEA, the NEA and the WENRA attended the meeting. The meeting discussed the main objectives, functions and forms of co-operation of the European Clearinghouse project. Small nuclear power countries have perceived the importance of the project for experience exchange due to the limited scope of their own experiences and resources. Early in 2008 the nuclear safety regulation organisations of the Netherlands, Lithuania, Romania, Slovenia, Switzerland and Hungary, as well as STUK, will conclude a co-operation agreement with the European Commission on their participation in the operation of the European Network on Operating Experience for NPPs. The relevant co-ordination centre, the EU Clearinghouse in NPP OEF, will be established in conjunction with the Institute for Energy, Joint Research Centre (IE-JRC). The participating countries have the possibility to post their own expert to the clearinghouse for a fixed term, the function of which is to assist the co-operating countries in producing high-quality operational event reports in the IAEA's IRS database, conducting related investigations and drafting summaries, and maintaining an operating experience feedback database. In support of its analyses, the clearinghouse will also utilise national experts from regulatory and technical support organisations.

STUK's proposal for a European Clearinghouse for operational experience feedback on nuclear power plant events included a globally available Safety Issues database, where all internationally interesting operational experience feedback from areas significant for nuclear safety would be concentrated and where it would be available to all. In December 2007 STUK's representatives participated in an Tecnical Meeting organised by the IAEA in Germany, where existing national databases were introduced and experiences were exchanged concerning the models applied in different countries to resolve recent events and the new factors revealed by research to have an impact on safety.

In 2007 the European Commission established a European High Level Group on Nuclear Safety and Radioactive Waste Management aimed at developing and harmonising the safety practices in the nuclear energy field in the EU Member States. Both nuclear energy countries and non-nuclear energy countries are involved in the Group's work.

Table 12. Bilateral co-operation.

Country/organisation	Form of co-operation with STUK
Sweden/SKI, the Swedish nuclear safety authority	STUK's representative is a member of the advisory committee on nuclear safety supporting SKI. Regular meetings with SKI to discuss topical issues concerning nuclear power plant safety regulation and emergency preparedness.
Belgium	STUK's Director General is the chairman of the advisory committee supporting the Belgian regulatory control organisation.
Lithuania/VATESI, the Lithuanian nuclear safety authority	STUK's representative acted as a permanent member of the advisory committee supporting the Lithuanian nuclear safety authority.
France	STUK's representative was a member of Group Permanent chargé des Reacteurs Nucléaires (GPR), the French advisory committee on nuclear safety. Co-operation in terms of the regulation of design, construction and manufacturing for the new plant project. Information on design solutions, the construction situation, oversight of construction, experience of the manufacturing of the main components and accident analyses were exchanged at the meetings.
USA	• Co-operation in terms of the regulation of design, construction and manufacturing for the new plant project. Information on design solutions, the construction situation, oversight of construction, experience of the manufacturing of the main components and accident analyses were exchanged at the meetings.
Russia	Co-operation in the field of nuclear safety with nuclear power plants in neighbouring areas and the Russian safety regulatory authorities in projects financed by the Ministry of Foreign Affairs. • Support to the Russian nuclear safety authorities in terms of nuclear safeguards. • Safety improvements at the Sosnovyi Bor nuclear power plant. • Safety improvements at the Kola nuclear power plant. • Co-operation with the Russian and Ukrainian nuclear safety authorities. • Accident preparedness and environmental radiation monitoring at Sosnovyi Bor, in St. Petersburg and the Kola peninsula. • Nuclear waste management co-operation in the neighbouring areas
Australia/ASNO, Australian Safeguards and Non-proliferation Office	Co-operation in the field of nuclear safeguards. STUK provides ASNO with information as agreed about nuclear materials of Australian origin imported to Finland.

The Finnish members of the Group are a representative of the Ministry of Trade and Industry and the Director General of STUK.

STUK contributed to the work of the advisory Expert Group A31, which assists in rule making in the field of nuclear safety in the European Commission, and the advisory committee on shipments of radioactive waste (the committee referred to in Article 21 of Directive 2006/117).

STUK attended the meetings of the Atomic Questions Group of the Council of the European Union dealing with the renewal of the Euratom safeguard system.

11.3 Other forms of co-operation

MDEP

STUK's representatives contributed to the work of the Steering Technical Committee (STC) and working groups of the Multinational Design Evaluation Programme (MDEP). Nine countries participate in the MDEP: the United States, Canada, France, Japan, China, Korea, Russia, South Africa, the United Kingdom and Finland. In practice, China has not sent representatives to the meetings.

The function of the MDEP STC is to assess regulatory practices and requirements related to the licensing of new plants in different countries, focusing on the licensing basis, inspection practices and safety objectives. Another aim is to define areas where different regulatory organisations could co-operate when granting licences to new plants. The project mainly deals with third-generation light-water and heavy-water reactors. In addition, STC's task is to issue recommendations for continued MPED operation.

The programme was launched with a pilot phase, on which a preliminary final report was completed based on summary reports by five working groups. The working groups dealt with the following topics: manufacturing standards and inspections of primary circuit components (WGCMOP, Working Group in Component Manufacturing), severe accidents, the requirements related to emergency cooling system design, programmable I&C, and generic issues concerning all of the above, such as the licensing process, documentation and the management system.

The preliminary final report presents areas with similarities and differences concerning regulatory requirements and practices, also describing the nature, importance and justifications of the differences. In addition, the report looks at areas of co-operation and the potential for harmonising regulatory practices. The report contains ten recommendations for continued operation. Continued operation of the programme will be decided on at a Policy Group meeting to be held in early 2008.

The WGCMO, the most active of the working groups, held three meetings in 2007 and visited factories manufacturing heavy components in France, South Korea and Japan. The working group submitted its final report according its mandate to the STC in the autumn of 2007. The working group's primary conclusions were to recommend establishing a multinational plant vendor inspection programme and launching preparations to harmonise standards for plant design and quality assurance.

The STC's final report based on the summary reports of the different working groups presents areas with similarities and differences concerning regulatory requirements and practices, and describes the nature, importance and justifications of the differences. In addition, the report looks at areas of co-operation and the potential for harmonising regulatory practices. The report contains ten recommendations for continued operation. The continuance of the programme will be decided on at a Policy Group meeting to be held in early 2008.

WENRA, Western European Nuclear Regulators' Association

STUK participated in the work of the Western European Nuclear Regulators' Association (WENRA, www.wenra.org), the co-operative body between the nuclear safety authorities of EU Member States using nuclear energy and Switzerland. In 2000 a working group on harmonisation was set up to develop a method for drawing up uniform nuclear safety requirements. According to the recommendations contained in the working group's final report, an extensive development project on requirements for nuclear safety and nuclear waste management was launched at the beginning of 2003. For this purpose, WENRA established two working groups:

- The Reactor Harmonisation Working Group (RHWG), whose task is to draw up reference requirements for existing nuclear power plants.
- The Working Group for Waste and Decommissioning (WGWD), whose task is to draw up reference requirements in the areas of decommissioning and storage of spent nuclear fuel and radioactive waste.

In 2006 the RHWG completed the harmonised reference levels applicable to reactor safety at operating plants (600 requirements). In 2007 the RHWG updated the requirements on the basis of comments from the industry and carried out benchmarking for management systems with regard to both regulations and operating nuclear power plants. Thus the RHWG has completed its mission, except for the follow-up of development in member countries, which is scheduled to be completed by the end of 2011. The objective for development is to bring the safety requirements applied in all of the countries in line with the reference levels.

The WGWD has outlined harmonised reference levels applicable to the storage of spent nuclear fuel and radioactive waste, and the decommissioning of nuclear power plants. In 2007 the WGWD compared national regulations with the reference levels to determine their correspondence. Based on the comparative experience and comments from the industry, the reference levels will be revised in 2008.

Nordic co-operation in nuclear safety

The four-year research programme of NKS, Nordic co-operation in nuclear safety, commenced in 2002. The programme comprises two project areas: reactor safety research and research into emergency preparedness and environmental safety. The projects are headed by programme managers. STUK's experts participated in projects under the research programme on emergency preparedness and environmental safety. STUK played an active role in the work of the NKS steering committee.

The nuclear safety programme includes projects relating to Finland's publicly funded SAFIR2010 research programme. The emergency preparedness and environmental safety programme includes focus areas important to Finland, such as the development of information management and communication during emergencies. The steering committee approved amendments to the framework programme in 2007. The objectives of the programme remain mostly unchanged. New topics for research include threats related to the use of radioactive substances, the environmental impact of uranium excavation and fourth-generation reactors. The programme's content in its entirety serves the co-operation between the Nordic authorities, which is a permanent objective of NKS co-operation.

NERS

STUK participated in the work of the Network of Regulators of Small Nuclear Programs (NERS). It is a channel via which information on the operating methods and experiences of colleagues working on similar-sized nuclear energy programmes can be exchanged. Nuclear safety authorities from countries outside Europe, Argentina, South Africa and Pakistan are participating in the co-operation. Three topics were dealt with in 2007: the MDEP, ensuring expertise and preparing for the construction of new plants, as well as safety culture when the structure of ownership changes.

VVER

STUK participated in the co-operation between the regulatory authorities of countries with VVER power plants via the VVER Forum. The annual meeting of the Forum deals with a few previously agreed topics and discusses the results of the Forum's working groups. Two working groups operated in 2007, which:

- exchanged operational experience feedback on VVER plants
- exchanged information on probabilistic risk analyses on VVER-440 plants and their results.